Capacity of Tile Drains and Open Ditch.

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It will be impossible for one not on the ground to appreciate the magnitude of the drainage craze which has taken possession of the land owners of Illinois. Owing to this great activity in drainage matters there are many inquiries as to the capacity of tile drains and open ditch. It has already been demonstrated that in certain localities large sums have practically been wasted owing to a neglect to inquire into the most elementary relations between the capacity of drains and the amount of water to be removed. Striking examples could be cited if it were necessary.

WATER TO BE REMOVED.

In this connection reference is generally made to the annual rain-fall, but this is of very little importance, for the drains to be of practical benefit must be proportioned to remove the greatest amount of rainfall that can be reasonably expected from time to time. All calculations of required capacity of drains must be based upon the probable amount or number of inches of rainfall in a given time. Crops do not flourish unless the water is removed within a comparatively short time after it falls. It is generally assumed that as a rule the water should be removed from the surface within twenty-four hours after it falls.

The annual rainfall in Illinois is about 41.0 inches per annum, of which about ? inches fall in the eight months from March to October inclusive. During these months there are six to eight showers in which more than 1 inch of water falls; in about half of that number more than one and a half inch falls, and there are one or two a year which give more than two inches per day. Or, in other words, about ten per cent. of the showers from March to October give a rainfall of more than one inch per day, about four per cent. give more than one and a half, and about one per cent. give more than 2 inches.

It is usually assumed that the drains should be proportioned to carry away, within twenty-four hours after it falls, the surface water from a shower of 1 inch. If the drains are proportioned to remove this amount of water, there will probably be a few showers each year, the water of which will not be removed in the given time; but these will occur so infrequently that it is generally assumed to be more economical to suffer the slight damage from the water which remains upon the surface for a few hours longer, than to be at the expense of increasing the capacity of the whole system. Although the showers in which the rainfall exceeds 1 inch occur comparatively seldom, yet they bring almost one-third of the water which falls during the growing season, and consequently should be provided for in all works for thorough drainage. If one wishes to do the work very thoroughly, he may provide for more than 1 inch of rain in twenty-four hours; and if another desires to lessen the first cost of his system, he need not provide for so much. With tile drains, it is practically impossible to increase the capacity after the tiles are laid, and since the additional expense is small, it is far better to have more rather than less. With open ditches it is a little different, the capacity of the ditch may increase by use, or it can be enlarged after it has been found too small. However, both the tile and the open ditch can be too large; it is desirable that each should be filled to its full capacity once or twice during the season, to remove sediment.

The rain which falls upon the earth does not all pass directly through or over it into the outlet. A portion of every rainfall is evaporated by the sun and wind, and a portion is held in the soil for a longer or shorter period. A German investigator gives the amount of water retained by 100 pounds of dry earth as follows:—sand, 25 pounds; loamy soil, 40 pounds; clay loam, 50 pounds: pure clay, 70 pounds. The evaporation from deep reservoirs used for city water supply averages, for the eight months from March to October, about $\frac{1}{10}$ of an inch of water per day; for the surplus from heavy showers remaining upon cultivated fields the evaporation would be very much more. Taking all these conditions into account, it is conceded that on an average not more than one-half to two-thirds of the water of a moderate storm finds its way into the outlet during the twenty-four hours following its fall. If provision be made by drains, to convey away one-half to two-thirds of an inch of solid rainfall in twenty-four hours, it is considered sufficient. The smaller of these two is more frequently employed.

Since some have confused the problem under discussion here, with another, but somewhat similar one, it may be well to turn aside a moment for a word of explanation. City engineers in designing a system of sewers for the removal of storm water give them a capacity sufficient to carry a rainfall of 1 *inch per hour*. But this is for city drainage, where the surface is largely covered with buildings and pavements, and consequently there is but little of the water retained by the soil, also the water must be removed so quickly that no allowance is made for evaporation; and finally the sewers must have sufficient capacity to *never* overflow, which would flood cellars and basements. Of course no one would ever knowingly think of proportioning a system of farm drainage on such a basis.

CAPACITY OF TILES.

So far as the writer can learn there have been no experiments to determine the capacity of a line of ordinary drain tile. There are numerous formulæ and tables which purport to give the capacity in cubic feet per day of different sizes of tile, or the number of acres that will be drained by the different sizes, but the data for all such formulæ and tables are derived from discussions and experiments in connection with the water supply of cities. Unfortunately the conditions involved in the distribution of water for a city are very different from those involved in the drainage of a farm. For example, the former is through iron pipes with comparatively few joints, while the latter is through earthern pipe with joints 1 foot apart; there are other equally important differences which will be discussed later. Nor is there anything like perfect harmony between the results obtained by different experimenters on flow of water through iron pipes; perhaps one observer used a short line of small pipe with a slight fall, another a long line of large pipe with great fall, while others used different combinations of the varying elements. It is not an unusual thing to find really competent authorities apparently differing 400 per cent. Hence the folly of trying to make a single series of experiments meet all conditions. The wide divergence between tables of the capacity of tile is probably due to the different authorities followed. At best, formulæ or tables of the capacity of tile derived from experiments upon the flow of water through iron pipes can only be approximate. From the very nature of the case the carrying capacity of a tile can not be stated with any thing like the accuracy with which the school-boy finds the square root of two.

It might seem that investigations in relation to sewer construction would have discovered results which would throw some light on the flow of water through earthern pipes, but there too the data developed in the distribution of water for cities are used, sometimes with slight modifications. Besides, the conditions in sewers are so very different from those in tile drains, that the results obtained in the one could not be used in the other.

The above explanations may seem to be a very peculiar introduction to a formula which rests upon the same uncertain foundations, but a full knowledge of the origin of an empirical formula is essential for its safe practical application. Serious errors are frequently made by unintelligent and improper use of such formulæ, which probably would not occur if their origin had been known.

Of the numerous formulae used for determining the flow of water in cast iron pipes the following—Beardmore's—is the oldest, the simplest and, with possibly one exception, as reliable as any; the later and possibly more accurate formula is too complicated to be of any practical use in this connection. If Q represent the number of cubic feet discharged in 24 hours; f the fall per foot expressed in feet; d the diameter of the pipe expressed in inches; and m a correction depending upon the roughness of the inside of the pipe; then

$$Q = m d^2 \sqrt{f d}$$

The principal difficulty is in finding the proper numerical value for m. For "smooth, clean cast iron pipes", with diameter and grade about as ordinary tile, m is 6794; for "slight rough" iron pipes under like conditions, m is 6020; and for "very rough" pipe, m is 4977.* These results are only approximate averages. If the grade is very slight the coefficient may be one-eighth less; and if it is very steep the coefficient may be one-eighth more. For the smaller pipe it may be a trifle less; and for 12-inch pipe it may be one-tenth more. However, such modification is probably only a mathematical illusion.

Unfortunately the value of m for tile is not known. Since there is a difference of nearly one-third between "smooth" and "very rough" iron pipe, it is possible that in applying these formulæ to tile we may miss the truth very greatly. So far as the writer has noticed, all formulæ used to determine the flow of water in tiles seem to assume that the carrying capacity of tile is the same as that of smooth, clean, cast iron pipe. Without considering the question of the relative smoothness of "smooth" cast iron pipe and drain tile, which obviously depends upon the place of manufacture, the writer is inclined to the belief that the capacity of a line of drain tile is less even than "very rough" cast pipe.

The latter are laid in 12-feet sections while the former are only 1 foot long; even if well laid a considerable part of the resistance is caused by the joints, and therefore will be more in drain tile than in water pipes. If one end of a tile gets tilted up, as it may in laying or by unequal settling of the ground, it not only diminishes the available section, but also diminishes the capacity of the unobstructed portion. The pipes draw their supply from a reservoir, and the water acquires the velocity due to the entire head; the tile draws its supply through every joint, and each addition reduces the velocity of the water already running in the tile. Tiles are often partially obstructed by sediment, grass, roots, etc. For these reasons the author believes that the carrying capacity of tile is usually overrated.

An inch of water over an acre amounts to 3630 cubic feet. Dividing the quantity which a tile will carry in 24 hours by the number of cubic feet of water per acre in a rainfall of 1-inch, we get the following formula, in which

*Fanning's Water Supply.

A represents the number of acres from which a tile d inches in diameter will remove an inch of water in 24 hours;

$$A = 1.4\, d^2 \sqrt{f\, d}.$$

To employ this formula just as it stands would give very thorough drainage, probably unnecessarily so, for it is only occasionally that one inch of water falls, and generally part of that is absorbed and held by the ground until after the surface water is entirely carried off. If the farmer wishes to make provision for carrying away about $\frac{2}{3}$ of an inch in twenty-four hours, use the formula

$$A = 2\, d^2 \sqrt{f\, d}.$$

Or if he wishes a cheaper system with less thorough drainage, that is, if he wishes to carry away a trifle less than half an inch, use the formula

$$A = 3\, d^2 \sqrt{f\, d}$$

The manner of using this formula will be readily understood, but the following example will make it still clearer. On the basis of removing half an inch of water per day, how much area will a 4-inch tile serve as an outlet for, the fall being one in a hundred? In this case $d = 4$; and $f = \frac{1}{100}$; hence

$$A = 3\,(4)^2 \sqrt{\tfrac{1}{100}} = 9.6;$$

that is, a 4-inch tile laid as above will carry off half an inch of water in twenty-four hours from 9.6 acres.

It will thus be seen that the formula is a condensed table from which results are obtained by a little arithmetical work. The formula is so simple that it can be remembered, and so always be ready for use. It may not be amiss to call attention to the fact that it is useless to attempt great mathematical exactness in such computations; for (1), in several particulars the foundation of the formula does not warrant it; (2) the sizes of the tile vary by inches and hence one size may be too small and the next as much too large, and 3) the exact area to be drained is never known with any considerable accuracy. In this computation bear in mind that the thoroughness of the drainage depends upon the amount of rainfall in twenty-four hours, the amount absorbed by the soil, and the formula adopted for the capacity of the tile.

Capacity of Open Ditches.

Fortunately we have more definite information about the capacity of an open ditch than about that of a tile drain; this is due to the fact that some of the experiments on the flow of water in open channels were made upon streams nearly like those whose capacity we wish to determine. However, we can never hope to attain mathematical accuracy in such computation.

The quantity of water flowing in an open channel depends upon the inclination of the bed of the stream, the depth of the water, the area of the cross-section of the stream, the portion of the cross-section of the bed and banks that is in actual contact with the water (called the wet perimeter), the smoothness of the surface in contact with the water, and the effect of the wind upon the upper surface. Numerous experimenters have sought to determine the law governing the relations of these several quantities, and various formulæ have been presented as embodying the results. Generally the object has been to measure the flow of rivers, but the experiments have been made upon small streams and in artificial channels; consequently the results are better suited to the purposes of this article than to the object for which they were deduced. By selecting the results of experiments on small channels, we can get results sufficiently accurate for all practical purposes.

Of the various formulæ presented for this purpose the latest, Kutter's is the simplest and most accurate. It is

$$Q = m\, a \sqrt{r f}$$

in which Q is the discharge in cubic feet per second; m is a correction co-efficient, a is the area of the cross-section of the stream, r is equal to the area of the cross-section, divided by the length of that portion of the cross-section of the bed and banks that is in actual contact with the water, and f is the fall per foot. All the dimensions must be taken in feet.

The reliability of the formula depends upon the value assigned to the co-efficient m to correct for friction. Experience shows that it is more for large or deep than for small or shallow streams; more for high than for low velocity; and more for smooth than for rough channels. By selecting results of experiments †, conditions somewhat like the ordinary drainage district ditch, we can get a mean value which we may use with some degree of confidence. For values of r (defined above) equal to $\frac{1}{2}$ m is 40; if r is 1, m is 45; if r is 2, m is 55; if r is 3, then m is 65; if r is 4, then m is 70; if r is 5, then m is 75; if r is 6, then m is 80.

The preceding results are for a clean ditch through earth free from stones; if the ditch becomes obstructed with weeds and grass, of course the coefficient should be very much reduced.

To change the above formula so that it will express the number of acres, represented by A, from which a given ditch will remove 1 inch of water in twenty-four hours, we multiply by the number of seconds in a day and divide by the number of cubic feet in an inch of water over an acre; then

$$A = 48\, m\, a \sqrt{r f}.$$

If it is desired to remove only two-thirds of an inch of water in twenty-four hours the formula becomes

$$A = 72\, m\, a \sqrt{r f}.$$

On the basis of removing a trifle less than half an inch per day the formula becomes

$$A = 100\, m\, a \sqrt{r f}.$$

To illustrate the use of this formula, let us assume that it is desired to find the number of acres from which a ditch 5 feet on the bottom with side slopes at 45° will remove one inch of water in twenty-four hours, the fall being 2 feet per mile and the water 3 feet deep in the ditch. The wetted perimeter is $5 + \sqrt{8} + \sqrt{8} = 15.6$ feet. The area is $3 \times 8 = 24$, $r = 24 \div 15.6 = 1.8$. Since r, the mean hydraulic depth, is 1.8, the coefficient m is about 52. A fall of 2 feet per mile is equal to a fall of .000379 feet per foot, which is the value of f. Substituting these values in the formula and working the arithmetic we find that this ditch will in twenty-four hours carry away half an inch of water over 3,240 acres. Similarly a ditch 30 feet wide on the bottom with water 5 feet deep and fall of 2 feet to the mile—a common Illinois drainage district ditch—will carry half an inch of water from 43,200 acres.

The ditches which are the main channels for a large territory will drain more acres than the number given by the preceding formula, for the water from the land near the outlet will have reached the main channel and passed away before that from the more remote area has arrived.

It is believed that the two preceding sets of formulæ if carefully used, are sufficient for the intelligent planning of large systems of drainage. Other questions than those here discussed will arise, but probably the above are the only ones which involve an appeal to experiments and mathematical formulæ.

†Fanning's Water Supply, p. 307.

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WASHINGTON, D. C.

(*Continued from Page 132.*

The following specifications for various classes of street-work in Washington are given in full for the reason that any abstract would be unsatisfactory to the reader:

SPECIFICATIONS.

Specifications for Grading.

The lines and grade of all excavation and embankment will be given from the office of the Engineer Commissioner, and no work will be commenced until these are established.

The material obtained in grading will be deposited in the localities previously named in the accompanying specifications; and no sand, gravel, cobblestones, curb, bricks, or pipe obtained in the excavation, or found on the premises, shall be considered the property of the contractor, nor used by him except as hereinafter prescribed.

The filling must be done in layers not exceeding eighteen (18) inches in thickness, so that the same may be well compressed by the driving of the carts over it.

The excavation will include only the road-bed, sidewalks, and the slope from them to the building line, according to the grade to be given by the Engineer Commissioner.

No more grading will be commenced at any one time than one square, except by permission of the Engineer Commissioner, and the filling will be brought up to grade established and shown by plans before the work can be accepted as completed.

All measurements will be made in excavation only.

Specifications for Setting Curb-Stones.

Curb stones will be of blue stone, 5 inches wide and 20 inches deep, or of granite, 6 inches wide and 20 inches deep. Circular curb will be of granite. The curb will be furnished by the district at the localities named in the approximate quantities.

The trench will be dug to the depth of twenty-four (24) inches, and eighteen (18) inches wide, to allow the earth to be rammed under and adjacent to the stone. A bed of gravel four (4) inches in depth, and eighteen inches wide will then be laid in the bottom of the trench, and thoroughly consolidated by ramming. On this bed the curb will be laid on the level and grade given from the office of the Engineer Commissioner; the joints to be close, and the outer and inner surfaces to be set even and in a continuous plane surface.

The ditch will be filled with gravel, the first filling to be not more than three (3) inches above the bottom of the stone, which will be well rammed by rammers or bars so as to give the curbs a solid bearing under its entire length. Other layers will then be rammed in the ditch to within ten (10) inches of the top of the curb; the layers for each ramming to be not more than four (4) inches deep.

Specifications for Granite Paving-Blocks, 1884.

Quality.—1st. The blocks may be of any syenite or granite equal in hardness to what is known as Quincy granite, but they must be of an uniform grain and texture, without lamination or stratification, and free from excess of mica or feldspar; hard basaltic stone, that will take a smooth polish under traffic, will not be accepted. Soft or weather-worn stones obtained from the surface of the quarry will not be accepted.

Size.—2nd. The blocks must be of the following dimensions, viz: In length, not more than 8 nor less than 6 inches; in width, not more than 5 nor less than 3 inches: in depth, not more than 6 nor less than 5½ inches. The size preferred is 7 inches long, 4 inches wide, and 6 inches deep. They must be sufficiently dressed to present rectangular faces, with straight edges on top, bottom, and sides, and all blocks whose faces vary more than ¼ an inch from a rectangular shape will be rejected. The sides and ends of the blocks must be so dressed that they will make close-fitting joints, and any block which has projections or knobs larger than ¼ an inch will be rejected.

Specifications for Laying Granite Block Pavement, 1884.

1. The granite block pavement will be laid on a foundation of gravel and sand, with filling of hot paving cement from coal-tar.

2. The stone blocks will be furnished by the district at——, and must be hauled to the street at the contractor's expense.

3. All wood blocks, etc., necessary to be removed shall be taken up and removed immediately from the line of the work. The subsoil or other matter is then to be excavated and removed to the depth of 12¼ inches below the top line of the proposed new pavement when

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fully rammed. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material will be removed and the space filled with clean gravel or sand. Care must be taked in excavating to preserve the proper crown, which will be sensibly the same as at present where the street is paved with wood or stone blocks. All holes and inequalities to be filled to a proper level with sand or gravel only, such filling to be well and faithfully compacted by rolling or ramming.

4. Upon the foundation as above is to be laid a bed of fine bank gravel, to be approved by the Engineer Commissioner, 4 inches in depth when compressed, to be screened from all pebbles measuring more than 1½ inches in their largest dimensions, and to be thoroughly rolled and rammed. Upon this will be laid a bed of fine, sharp, washed sand, thoroughly dry, 3 inches in thickness, to serve as a bed for the blocks, which will be laid directly upon and imbedded in it, with close joints. The stone blocks are to be laid at right angles with the line of the street, with such crown as the Engineer may direct; each course to be of blocks of a uniform width and depth, and so laid that all longitudinal joints shall be broken by a lap of at least 2 inches. When thus laid, the blocks shall be immediately covered with clean, fine, hot gravel in proper quantities, and raked until all the joints become filled therewith, and the blocks will then be carefully rammed to a firm, unyielding bed, with uniform surface, and with proper grade and crown. There will then be poured into the joints, at a temperature of 300° Fahrenheit, paving cement of proper consistency, to be approved by the Engineer Commissioner, to be obtained by the direct distillation of coal-tar, and to be the residuum therefrom. The cement required is ordinarily numbered between five and six at the manufactory. It will be poured into the joints of the pavement until the sand beneath and the gravel between the blocks will absorb no more and the joints are filled flush with the upper surface of the pavement. Dry hot gravel, not larger than ¾ of an inch in any dimension, will then be poured along the joints filled with paving cement as just described, and will be consolidated by tapping with a light rammer. Not less than 3½ gallons of paving cement to each square yard of pavement will be required; this quantity must be brought upon the ground, upon the line of the work, and whatever may remain after the completion of the work will be the property of the District of Columbia, and will be hauled to the Sixth street property yard at the expense of the contractors. Any wastage of paving cement by pouring over the surface of the pavement instead of between the blocks will be estimated and deducted from the amount reported to have been used, and any such wastage of paving cement remaining upon the surface of the pavement must be covered with a sufficient quantity of fine dry gravel to absorb it.

Specifications for Laying Asphaltum Pavements, 1884.

1. Asphaltum pavements will be 2½ inches in thickness when compressed, with a base of hydraulic cement concrete 6 inches in depth.

2. The sand beneath the present wood pavement, and all other material necessary to be removed, will be removed from the street; soft or spongy places, not affording a firm foundation, will be dug out and refilled with good earth, well rammed, and the entire roadbed will be thoroughly rolled with a heavy steam-roller.

Upon the foundation as above will be laid a bed of hydraulic cement concrete 6 inches in thickness, to be made as follows:

One measure of cement equal to the best quality of fresh-burned Cumberland or Shepherdstown cement, manufactured upon the formula of this office, and two of clean, sharp, washed sand, free from clay, will be thoroughly mixed, dry, and then made into a mortar with the least possible amount of water; broken stone or brick, thoroughly cleaned from dust and dirt, drenched with water, but containing no loose water in the heap, will then be incorporated immediately with the mortar in such quantities as will give a surplus of mortar when rammed. This proportion, when ascertained, will be regulated by measure. Each batch of concrete will be thoroughly mixed, the mixing being continued on the board until each piece of stone or brick is completely coated with mortar; it will then be spread, and at once thoroughly compacted by ramming until free mortar appears upon the surface. The whole operation of mixing and laying each batch will be performed as expeditiously as possible, with the use of a sufficient number of skilled men. No gravel will be used in the concrete, but only angular fragments of stone or brick, having rough faces obtained by fracture, and measuring not more than 2½ inches in their largest dimensions. The upper surface will be made exactly parallel with the surface of the pavement to be laid, and will be protected from the action of the sun and wind until set. Upon this base will be laid the wearing surface or pavement proper, the basis of which, or paving cement, will be pure asphaltum, unmixed with any of the products of coal-tar.

3. Where the pavement is laid adjacent to the track of a street railway a strip, 2 feet wide, of paving blocks of granite or syenite will be laid next the track, with a foundation of bituminous concrete extending to the depth of the bottom of the cross-ties. This foundation will consist of small broken stone, clean, sharp sand and paving cement of coal-tar from direct distillation of the consistency usually numbered between four and five. The ingredients and their relative proportions of this foundation will be such as to constitute a solid base of broken stone, the voids of which are filled with sand and paving cement, and will require the approval of the Engineer Commissioner. The joints between the paving blocks will be filled with a hot paving cement, composed of refined asphalt, 100 parts, and heavy petroleum oil, ten parts; or of cement obtained from the direct distillation of coal-tar, and of the consistency ordinarily numbered between five and six.

These blocks will be laid as headers, and the alternate courses will be 22 and 26 inches in length, so as to form a toothing where the stone pavement joins the asphalt. The width of the blocks will be from 4 to 6 inches, and their depth from 5 to 6 inches. The dimensions here given will be strictly adhered to, and the blocks must be of durable and uniform quality, selected for this purpose. The blocks will be carefully inspected after they are brought on the line of the work, and all blocks which in quality and dimensions do not conform strictly to these specifications will be rejected, and will be immediately removed from the line of work. Contractors will be required to furnish such laborers as may be necessary to aid the inspector in the examination and culling of the blocks; and in case the contractors shall neglect or refuse to so do, such laborers as in the opinion of the Engineer Commissioner may be necessary will be employed, and the expense incurred will be deducted and paid out of any money then due, or which thereafter may become due the contractors. The blocks may be of any syenite or granite, equal in hardness to what is known as Quincy granite; but hard, basaltic stone that will take a smooth polish under traffic will not be used.

Where the new pavement joins an existing wood pavement a 3-inch pine plank will be set on edge between the two, and both pavements fitted well up against it. Where the new pavement joins an existing stone pavement, a line of parking curb will be set on edge between the two, and both pavements fitted well up against it. This curb will be furnished by the district at the G street property yard, and must be hauled to the work and placed in position at the contractor's expense.

4. The following specifications for wearing surface will be adhered to unless a more satisfactory pavement should be presented:

The wearing surface will be composed of—

1st. Refined Trinidad or Cuban asphaltum.

2d. Heavy petroleum oil.

3d. Fine sand, containing not more than 1 per centum of hydrosilicate of alumina.

4th. Fine powder of carbonate of lime.

The Trinidad asphaltum (so called), whether crude or refined, as found in this market, contains from 20 to 35 per centum of impurities, and must be refined and brought to an uniform standard of purity and gravity.

The Cuban asphalt contains a greater percentage of asphaltene and less of petrolene than the Trinidad asphalt, and therefore requires a larger percentage of heavy petroleum oil to make an asphaltic cement of a similar quality as to its malleability.

The heavy petroleum oil, which may be the residuum by distillation of the petroleum oils, as found in the market, generally contains water, light oils, coke, and a gummy substance soluble in water. This petroleum oil must be freed from all impurities and brought to a specific gravity of from 18° to 22° Beaumè, and a fire test of 250° Fahrenheit.

By melting and mixing these two hydrocarbons, petroleum oil and asphaltum, the matrix of the pavement called asphaltic cement is manufactured, which cement shall have a fire test of 250° Fahrenheit, and, at a temperature of 60° Fahrenheit, shall have a specific gravity of 1.19.

They will be mixed in the following proportions, by weight:

With Trinidad Asphalt.

Pure asphalt	100 parts.
Heavy petroleum oil	20 parts.

With Cuban Asphalt.

Pure asphalt	100 parts.
Heavy petroleum oil	30 parts.

The purity of the asphalt shall be ascertained, and the quantity of heavy petroleum oil to be added to it shall be in accordance with the percentage of pure asphalt which it contains when crude, whether Cuban or Trinidad asphalt.

The asphaltic cement being made in the manner above described, the pavement mixture will be formed of the following materials, and in the proportions stated:

Asphaltic cement	from	15 to 18
Sand	from	70 to 65
Pulverized carbonate of lime	from	15 to 17
		100 100

In order to make the pavement homogeneous, the proportion of asphaltic cement must be varied according to the quality and character of the sand. The Engineer Commissioner, or his inspectors, will make frequent inspections of the works where the paving mixture is manufactured, and will specify the exact amount of asphaltic cement, between the limits above given, which shall be used in each batch. If the proportions of the mixture are varied in any manner from those specified by the inspector, the mixture will be rejected and condemned, either before or after it is placed on the street. Its use will not be permitted, and, if already placed on the street, it will be removed and replaced by proper material at the expense of the contractor.

The sand and asphaltic cement are heated seperately to about 300° Fahrenheit. The pulverized carbonate of lime, while cold, is mixed with the hot sand in the required proportions, and is then mixed with the asphaltic cement at the required temperature and in the proper proportion, in a suitable apparatus which will effect a perfect mixture.

The pavement mixture, prepared in a manner thus indicated, will be laid on the foundation in two coats. The first coat, called cushion coat, will contain from 2 to 4 per cent. more asphaltic cement than given above; it will be laid to such depth as will give a thickness of half an inch after being consolidated by a roller. The second coat, called surface coat, prepared as above specified, will be laid on the cushion coat. It will be brought to the ground in carts, at a temperature of about 250° Fahrenheit, and, if the temperature of the air is less than 50°, the contractor must provide iron carts, with heating apparatus, in order to maintain the proper temperature of the mixture. It will then be carefully spread, by means of hot iron rakes, in such manner as to give a uniform and regular grade, and to such depth that, after having received its ultimate compression of two-fifths, it will have a thickness of 2 inches. This depth will be constantly tested by means of gauges furnished by the Engineer Commissioner. The surface will then be compressed by hand rollers, after which a small amount of hydraulic cement will be swept over it, and it will then be thoroughly compressed by a steam roller weighing not less than 250 pounds to the inch run, the rolling being continued for not less than five hours for every 1,000 yards of surface.

All materials used will be subject to inspection, and will be of the quality and kind now on file in the office of the Engineer Commissioner.

The degree of fineness, both of sand and powdered limestone, will be determined by testing with the screens now on file in the Engineer Department.

The powdered cabonate of lime will be of such degree of fineness that 16 per centum by weight of the entire mixture for the pavement shall be an impalpable powder of limestone, and the whole of it shall pass a No. 26 screen. The sand will be of such size that none of it will pass a No. 80 screen, and the whole of it shall pass a No. 20 screen.

In order to make the gutters, which are consolidated but little by traffic, entirely impervious to water, a width of 12 inches next the curb will be coated with hot pure asphalt and smoothed with hot smoothing-irons, in order to saturate the pavement to a certain depth with an excess of asphalt.

5. If considered advisable, a strip of granite block pavement will be laid in the place of the gutter, of such width as may be prescribed and in accordance with the specifications for granite block pavements. In this case the edge next the carriageway will consist of headers toothing into the pavement of the carriageway.

Specifications for Compressed Asphalt Paving Blocks, 1883.

Size. 1st. The size of the blocks will be 4 x 5 x 12 inches, and a variation of ¼ inch from these dimensions will be sufficient grounds for rejecting any block.

Quality. 2nd. The blocks will be composed of

Paving Cement	8 to 12
Crushed Limestone	92 to 88
	100 to 100

The paving cement will be made from refined asphalt from Cuba or Trinidad, and the petroleum oil obtained from the distillation of petroleum and being the residuum therefrom. No product of the distillation of coal tar will be permitted in the paving cement. The right is reserved to inspect the manufacture of the blocks at any time.

Specifications for Laying Compressed Asphalt Block Pavement.

1. The asphalt pavement will be laid on a foundation of gravel and sand.

2. The asphalt blocks will be furnished by the district at the following locality, viz.: ——, and must be hauled to the street at the contractor's expense.

3. All wood blocks, etc., necessary to be removed shall be taken up and removed immediately from the line of work. The subsoil or other matter is then to be excavated and removed to the depth of 12 inches below the top line of the proposed new pavement when fully rammed. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material will be removed and the space filled with clean gravel or sand. Care must be taken in excavating to preserve the proper crown, which will be sensibly the same as at present where the street is paved with wood or stone blocks. All holes and inequalities to be filled to a proper level with sand or gravel only, such filling to be well and faithfully compacted by rolling or ramming.

4. Upon the foundation as above is to be laid a bed of fine bank gravel, to be approved by the Engineer Commissioner, 4 inches in depth when compressed, to be screened from all pebbles measuring more than 1¼ inches in their largest dimensions, and to be thoroughly rolled and rammed. Upon this will be laid a bed of fine, sharp, washed sand, thoroughly dry, 3 inches in thickness, to serve as a bed for the blocks, which will be laid directly upon and embedded in it with close joints. Special care will be observed to make the surface of this bed of sand exactly parallel to the surface of the pavement when complete; this will be accomplished by dragging a straight-edge over it, or otherwise. The blocks must be laid by the pavers standing or kneeling upon the blocks already laid, and not upon the bed of sand.

The blocks are to be laid at right angles with the line of the street, with such crown as the Engineer Commissioner may direct; each course to be of blocks of a uniform width and depth, and so laid that all longitudinal joints shall be broken by a lap of at least 4 inches. Each course of blocks will be driven against the course preceding it by a heavy maul, in order to make the joints as tight as possible. When thus laid the blocks will be immediately covered with clean, fine sand, entirely free from any loam or earthy matter, perfectly dry, and screened through a sieve or screen having not less than twenty meshes to the inch. The blocks will then be carefully rammed by placing a plank over several courses and ramming the plank with a heavy rammer. The ramming will be continued until the blocks reach a firm, unyielding bed and present a uniform surface, with proper grade and crown. Any lack of uniformity in the surface must be corrected by taking up and relaying the blocks. When the ramming is complete a sufficient amount of fine, dry sand, as above described, will be spread over the surface and swept or raked into the joints.

Specifications for Laying Cobble Gutters and Crossings.

The earth, stone and other materials necessary to be removed will be taken out for a depth of 12 inches below the top line of the proposed gutter or crossing when fully packed. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material will be removed and the space filled with clean sand or gravel.

All holes or inequalities to be filled to a proper level with sand or gravel only, such filling to be well compacted by rolling or ramming. Upon the foundation thus prepared is to be laid a bed of good gravel, 5 inches in thickness, which will be thoroughly compacted by rolling or ramming. On this will be spread a layer of clean, sharp sand, to serve as a bed for the paving-stones, of such depth as may be required to bring the work to grade.

The cobble stones will be assorted as they are brought upon the ground, and no stones that are less than four (4) inches nor more than six (6) inches long, and not less than (2) nor more than four (4) inches wide will be used, and the several sizes will be laid so as to make an even surface when rammed. When thus laid the stones shall be immediately covered with clean, fine sand, in proper quantities, and raked until the joints become filled therewith; the stones shall then be thoroughly rammed to a firm, unyielding bed with an uniform surface and proper grade.

The foundation for the gutter and crossing flag shall be prepared in the same manner as described for cobble, upon which the flag will be laid with close joints and settled into place solidly, but in such manner as not to fracture the flag.

Specifications for Laying Macadam Pavement.

1. Macadam pavements will be 12½ inches thick when fully compressed and will be laid in three courses, the two lower courses each being 6 inches thick when compressed and the top course ½ inch.

2. The space over which the pavement is to be laid will be excavated to the depth of twelve and one-half (12½) inches below the top line of the proposed new pavement when fully compressed. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material will be removed and the space filled with clean gravel or sand. Care must be taken in excavating to preserve the proper crown, parallel to the surface of the street when completed.

All holes and inequalities to be filled to a proper level with sand or gravel only, such filling to be well and faithfully compacted by rolling or ramming, and the entire road-bed will be thoroughly compacted by rolling and ramming so as to present a smooth and regular surface.

3. On this bed the metal for the first course will be spread in a uniform layer of such thickness as to give a depth of 6 inches when thoroughly compacted. This layer will then be compacted by rolling, and ramming in such places as the roller cannot reach; the roller will either be a steam-roller or horse-roller, its weight being not less than 5,000 pounds and its width such that the weight per inch of run will not be less than 125 pounds. The district will furnish, if desired, a suitable roller weighing about 10,500 pounds made of iron with grooves and requiring five or six horses for its proper use according to grade. The rolling will be continued until the stones cease to sink under the roller or to creep in front of it; the amount of rolling will not be less than ten hours to each 1,000 yards of surface.

4. The second course of metal will be spread on the first course in a uniform layer of the same depth as before, and after being thoroughly wet either by hose or a sprinkling cart, will be rolled and rammed in precisely the same manner and to the same extent as the first course.

5. The size of metal in the first and second courses will be such that it will pass through a ring 2½ inches in diameter; *i. e.* the largest dimension of any stone must not exceed 2½ inches. Any stone larger than this will be absolutely rejected, and must be either removed from the street or rebroken to proper size by the contractor. The material for the top course will be small pebbles thoroughly screened from clay and earthy matter and varying in size from ⅜ to ¾ of an inch in their largest dimensions, or it may be composed of the finer particles of stone obtained by screening the stone for the lower courses. These particles of stone will be of the same size as the pebbles above mentioned. Stone dust will not be used for a top course.

6. The material for the top course will be spread upon the second course in a uniform layer 1 inch in thickness, and after being thoroughly wet by means of a hose or sprinkling cart, will be rolled and rammed in the same manner and to the same extent as the first and second courses.

7. The stone for the first and second courses must be of a hard and compact texture and uniform grain. Blue rock (gneiss), trap, granite, flint (quartz), and the harder varieties of lime stone will be accepted. Bidders will submit with their bids, samples of the stone which they propose to furnish, and all stone which does not equal the sample in quality and size will be rejected. The stone must have on all sides a rough surface obtained by fracture. Water-worn pebbles and broken cobble stones will not be accepted. The stone preferred is the harder variety of compact gneiss found on certain portions of Rock Creek, Piney Branch, Broad Branch and other streams north of the Boundary. Disintegrated and weather-worn stones from the surface of the quarry will not be accepted. If desired, the stone can be obtained from the shafts of the new Aqueduct at Champlain avenue, Rock creek, and Foundry Branch. It will be furnished to the contractor at those points free of charge and already broken to a size containing about one cubic foot.

Specifications for Laying Gravel Roadway.

The bed of the street over which the gravel is to be laid will be dressed to an even surface sloping from the center to the lines of the curbs. This surface will be six inches below the top of the curbs of the center and 10 inches below the top of the curbs at the edge of the gutter.

The road-bed must be well-rolled and dressed, as above, before the gravel is laid. Where there is not a superintendent appointed for this special work, twenty-four (24) hours notice must be given to the Engineer Commissioner that the road-bed is ready for inspection. The entire space between two (2) streets must be prepared for inspection before such notice is given. No gravel will be laid on the road-bed until such inspection is made.

On this bed, thus prepared, the gravel will be laid of such thickness that when thoroughly rolled it will be ten (10) inches deep at the center and eight (8) inches at the sides, and rounded from side to side, as may be directed by the Engineer Commissioner. The gravel must be free from loam and of a quality to be approved by the Engineer Commissioner, and none must be larger than will pass through a ring 2 inches in diameter. It will be laid in two (2) equal layers, and each layer will be compacted by rolling with a four-horse roller, until the gravel is thoroughly packed and has a firm even surface. The amount of rolling necessary for this is about ten hours for every thousand yards of surface for each layer.

Breaking Streets.

Before breaking any street, either for repairs of sewers, steam or water-service pipes or for making connections with a main, the owner of the premises must apply to the engineer department for, and obtain, a permit, in which application he must name the plumber who is to do the work. A charge of one dollar is made for each connection, but if water and sewer are both put in at once, and in the same trench, only one dollar is charged for both; water mains are tapped by the water department, for which an additional fee of three dollars is charged. No two houses are allowed to connect with the same service-pipe. Before breaking a street paved with granite block or asphalt a deposit of ten dollars must be made to cover the cost of repairing the pavement, which is done by the Superintendent of Streets for granite block, and by the contractor for repairs on asphalt, sidewalks are repaired by the plumber. Gas mains are tapped by employés of the gas company, which is under contract with the city to pay into the general fund one dollar for each house connected, and to pay all costs for repairing pavements of streets. Under these permits twenty days are allowed in which to make the connection, and before filling the trench the work must be inspected by an inspector in the employ of the city. Within forty-eight hours after a connection is made the trench must be filled, puddled, and thoroughly rammed. The entire work must be finished and the street put in perfect order within thirty days from the issuance of the permit. Immediately after the expiration of the thirty days an inspector of surface work, examines the street and reports the condition of the same to the engineer department. None but bonded plumbers are allowed to do any work outside the building lines of the street. Each plumber is required to execute a bond in the sum of five hundred dollars, conditional on the faithful carrying out of all rules and regulations of the Commissioners thereto.

On new work it is the policy to lay sewers, gas and water mains before paving a street, and as the whole matter is directly under the control of the Engineer Commissioner, there is no clashing in regard to the time of doing the work.

(TO BE CONTINUED.)

Electric Light vs. Gas.

The great advantage, from a hygienic point, of the electric light over gas in halls where large numbers assemble, is well shown by the elaborate researches of Dr. Breslauer, and recorded in the *Deutsché medicinische zeitung*. The experiments were made in the Munich theatre, and included an inquiry into the air of the different portions of the house as to temperature and the products of combustion. The temperature was increased in the parquet ten times more with gas than with the electric light, and three times more in the gallery. The amount of carbonic acid per 1,000 was,—

	Electric light.	Gas.
In parquet	0.055	3.926
In gallery	0.870	3.151
In center of gallery	1.178	4.353

This increase in the amount of carbonic acid is one of the principal disadvantages of gas as compared with the electric light. The conclusions which are drawn from these observations are that the air remains much purer and at a lower temperature in all parts of the house, especially in the galleries, when electric light is employed as a means of illumination.—*Science.*

The Trigonometrical Survey of India.*

Scientific geography embraces a wide range of subjects, wider than can be claimed for any other department of science. I shall, however, restrict my address to the subject with which I am most familiar, and give you some account of the survey of India, and more particularly of the labors of the trigonometrical or geodetic branch of that survey, in which the best years of my life have been passed.

I must begin by pointing out that the survey operations in India have been very varied in nature, and constitute a blending together of many diverse ingredients. Their origin was purely European, nothing in the shape of a general survey having been executed under the previous Asiatic Governments; lands had been measured in certain localities, but merely with a view to acquiring some idea of the relative areas of properties, in assessing on individuals the share of the revenue levied on a community; but other factors than area—such as richness or poverty of soil, and proximity or absence of water—influenced the assessment, and often in a greater degree, so that very exact measurements of area were not wanted for revenue purposes, and no other reason then suggested itself why lands should be accurately measured. The value of accurate maps of individual properties, with every boundary clearly and exactly laid down, was not thought of in India in those days, and indeed has only of late years begun to be recognized by even the British Government. The idea of a general geographical survey never suggested itself to the Asiatic mind. Thus when Englishmen came to settle in India, one of their first acts was to make surveys of the tracts of country over which their influence was extending; and as that influence increased, so the survey became developed from a rude and rapid primary delineation of the broad facts of general geography, to an elaborately executed and artistic delineation of the topography of the country, and in some provinces to the mapping of every field and individual property. Thus there have been three orders or classes of survey, and these may be respectively designated geographical, topographical, and cadastral; all three have frequently been carried on *pari passu*, but in different regions, demanding more or less elaborate survey according as they happen to be more or less under British influence. There is also the Great Trigonometrical or Geodetic Survey, by which the graphical surveys are controlled, collated, and co-ordinated, as I will presently explain.

Survey operations in India began along the coast-lines before the commencement of the seventeenth century, the sailors preceding the land surveys by upwards of a century. The Directors of the East India Company, recognizing the importance of correct geographical information for their mercantile enterprises, appointed Richard Hakluyt, Archdeacon of Westminister, their historiographer and custodian of the journals of East Indian voyages, in the year 1601, within a few weeks of the establishment of the company by Royal Charter. Hakluyt gave lectures to the students at Oxford, and is said by Fuller to have been the first to exhibit the old and imperfect maps and the new and revised maps for comparison in the common schools, "to the singular pleasure and great contentment of his auditory." The first general map of India was published in 1752 by the celebrated French geographer D'Anville, and was a meritorious compilation from the existing charts of coast-lines and itineraries of travelers. But the Father of Indian Geography, as he has been called, was Major Rennell, who landed in India as a midshipman of the royal Navy in 1760, distinguished himself in the blockade of Pondicherry, was employed for a time in making surveys of the coast between the Paumben Passage and Calcutta, was appointed Surveyor of the East India Company's dominions in Bengal in 1764, was one of the first officers to receive a commission in the Bengal Engineers on its formation, and in 1767 was raised to the position of Surveyor-General. Bengal was not in those days the tranquil country we have known it for so many years, but was infested by numerous bands of brigands who professed to be religious devotees, and with whom Rennell came into collision in the course of one of his surveying expeditions, and was desperately wounded; he had to be taken 300 miles in an open boat for medical assistance, the natives meanwhile applying onions to his wounds as a cataplasm. His labors in the survey of Bengal lasted over a period of nineteen years, and embraced an area of about 300,000 square miles, extending from the eastern boundaries of Lower Bengal to Agra, and from the Himalayas to the borders of Bandelkand and Chota Nagpur. Ill-health then compelled him to retire from the service on a small pension and return to England; but not caring, as he said, to eat the bread of idleness, he immediately set himself to the utilization of the large mass of geographical material laid up and perishing in what was then called the India House; he published numerous charts and maps and eventually brought out his great work on Indian Geography, the "Memoir of a man of Hindostan," which went through several editions; this was followed by his Geographical System of Herodotus, and various other works of interest and importance. His labors in England extended over a period of thirty-five years, and their great merits have been universally acknowledged.

Rennell's system of field-work in Bengal was a survey of routes checked and combined by astronomical determinations of the latitude and the longitude, and a similar system was adopted in all other parts of India until the commencement of the present century. But in course of time the astronomical basis was found to be inadequate to the requirements of a general survey of all India, as the errors in the astronomical observations were liable materially to exceed those of the survey, if executed with fairly good instruments and moderate care. Now this was no new discovery, for already early in the eighteenth century the French Jesuits who were making a survey of China—with the hope of securing the protection of the Emperor, which they considered necessary to favor the progress of Christianity—had deliberately abandoned the astronomical method and employed triangulation instead. Writing in the name of the missionaries who were associated with him in the survey, Pére Regis enters fully into the relative advantages of the two methods, and gives the trigonometrical the preference, as best suited to enable the work to be executed in a manner worthy the trust reposed in them by a wise prince, who judged it of the greatest importance to his State. "Thus," he says, "we flatter ourselves we have followed the surest course, and even the only one practicable in prosecuting the greatest geographical work that was ever performed according to the rules of art."

What was true in those days is true still; points whose relative positions have been fixed by any triangulation of moderate accuracy present a more satisfactory and reliable basis for topographical survey than points fixed astronomically. Though the lunar theory has been greatly developed since those days by the labors of eminent mathematicians, and the accuracy of the lunar tables and star catalogues is much increased, absolute longitudes are still not susceptible of ready determination with great exactitude; moreover, all astronomical observations, whether of latitude or longitude, are liable to other than intrinsic errors, which arise from deflection of the plumb-line under the influence of local attractions, and which of themselves materially exceed the errors that would be generated in any fairly executed triangulation of a not excessive length, say not exceeding 500 miles.

Thus at the close of the last century Major Lambton, of the 33rd Regiment, drew up a project for a general triangulation of Southern India. It was strongly supported by his commanding officer—Colonel Wellesley, afterwards the Duke of Wellington—and was readily santioned by the Madras Government: for a large accession of territory in the center of the peninsula had been recently acquired, as the result of the Mysore campaign, by which free communication had been opened between the east and west coasts of Coromandel and Malabar; and the proposed triangulation would not merely furnish a basis for new surveys, but connect together various isolated surveys, which had already been completed or were then in progress. The Great Trigonometrical Survey of India owes its origin as such, and its simultaneous inception as a geodetic survey, to Major Lambton, who pointed out that the trigonometrical stations must needs have their latitudes and their longitudes determined for future reference just as the discarded astronomical stations, not however by direct observation, but by processes of calculation requiring a knowledge of the earth's figure and dimensions. But at that time the elements of the earth's figure were not known with much exactitude, for all the best geodetic arcs had been measured in high latitudes, the single short and somewhat questionable arc of Peru being the only one situated in the vicinity of the equator. Thus additional arcs in low latitudes, as those of India, were greatly needed and might be furnished by Lambton. He took care to set this forth very distinctly in the programme which he drew up for the consideration of the Madras Government remarking that there was thus something still left as a desideratum for the science of geodesy, which his operations might supply, and that he would rejoice indeed should it come within his province "to make observations tending to elucidate so sublime a subject."

Lambton commenced operations by measuring a base line and a small meridional arc near Madras, and then, casting a set of triangles over a southern peninsula, he converted the triangles on the central meridian into a portion of what is now known as the Great Arc of India, measuring its angles with extreme care, and checking the triangulation by base lines measured at distances of 2 to 3 degrees apart in latitude. His principal instruments were a steel measuring chain, a great theodolite, and a zenith sector, each of which had a history of its own before coming into his hands. The chain and zenith sector were sent from England with Lord Macartney's Embassy to the Emporer of China, as gifts for presentation to that potentate, who unfortunately did not appreciate their value and declined to accept them; they were then made over to Dr. Dinwiddie, the astronomer to the embassy, who took them to India for sale. The theodolite was constructed in England for Lambton, on the model of one in use on the Ordnance Survey; on its passage to India it was captured by the French frigate, the *Piedmontaise*, and landed at Mauritius, but eventu-

*By Gen. J. T. Walker, C. B., LL.D., F.R.S., F.R.G.S., before the British Association for the Advancement of Science at Aberdeen, 1885.

ally it was forwarded to its destination by the chivalrous French Governor, De Caen, with a complimentary letter to the Governor of Madras.

Lambton was assisted for a short time by Captain Kater, whose name is now best known in connection with pendulum experiments and the employment of the second's pendulum as a standard of length; but for many years afterwards he had no officer to assist him. At first he met with much opposition from advocates of the discarded astronomical method, who insisted on its being sufficiently accurate and more economical than the trigonometrical. But he was warmly supported by Maskelyne, the Astronomer-Royal in England, and soon had an opportunity of demonstrating the astronomical method to be fallacious, for its determination of the breadth of the peninsula in the latitude of Madras was proved by the triangulation to be forty miles in error. Still, for several years he never received a word of sympathy, encouragement, or advice either from the Government or from the Royal Society. A foreign nation was the first to recognize the importance of his services to science, the French Institute electing him a corresponding member in 1817. After this, honors and applause quickly followed from his own countrymen. In 1818 the Governor-General of India—then the Marquis of Hastings—decided that the survey should be withdrawn from the supervision of a local Government and placed under the Supreme Government, with a view to its extension over all India, remarking at the same time that he was "not aware that with minds of a certain order he might lay himself open to the idle imputation of vainly seeking to partake the gale of public favor and applause which the labors of Colonel Lambton had recently attracted;" but as the survey had reached the northern limits of the Madras Presidency, its transfer to the Supreme Government, if it was to be further extended, had became a necessity. He directed the transfer to be made, and the survey to be called in future the Great Trigonometrical Survey of India. Noticing that the intense mental and bodily labor of conducting it was being performed by Lambton alone, that his rank and advancing age demanded some relief from such severe fatigue, and farther, that it was not right that an undertaking of such importance should hang on the life of a single individual, the Governor-General appointed two officers to assist him—Captain Everest, as chief assistant in the geodetic operations; and Dr. Voysey, as surgeon and geologist. Five years afterwards Lambton died, at the age of seventy. The happy possessor of an unusually robust and energetic constitution and a genial temperament, he seems to have scarcely known a day's illness, though he never spared himself nor shrank from subjecting himself to privations and exposure which even Everest thought reckless and unjustifiable. These he accepted, as a matter of course, saying little about them, and devoting his life calmly and unostentatiously to the interests of science and the service of his country.

Everest's career in the survey commenced disastrously. He was deputed by Lambton to carry a triangulation from Hyderabad, in the Nizam's territory, eastwards to the coast, crossing the forest-clad and fever-haunted basin of the Godavery river, a region which he described as "a dreadful wilderness, than which no part of the earth was more dreary, desolate and fatal." Indignant at being taken there, his escort, a detachment of the Nizam's troops, mutinied, and soon afterward he and his assistants, and almost all the men of his native establishment, were stricken down by a malignant fever; many died on the spot, and the survivors had to be carried into Hyderabad, whence litters and vehicles of all descriptions, and the whole of the public elephants, were despatched to their succor. To recover his health Everest was compelled to leave India for a while and proceed to the Cape of Good Hope, where he remained for three years. He availed himself of the opportunity to inspect Lacaille's meridional arc, which, when compared with the arcs north of the equator, indicated that the opposite hemispheres of the globe were seemingly of different ellipticities. He succeeded in tracing this anomaly to an error in the astronomical amplitude of the arc, which had been caused by deflection of the plumb-line at the ends of the arc, under the influence of the attraction of neighboring mountains. Thus he became aware of the necessity of placing the astronomical stations of the Indian arcs at points where the plumb-line would not be liable to material deflection by the attraction of neighboring mountain ranges. Shortly after his return to India Lambton died, and Everest succeeded him, and immediately concentrated his energies on the extension of the Great Arc northwards. He soon came to the conclusion that his instrumental equipment, though good for the time it was procured, and amply sufficient for ordinary geographical purposes, was inadequate for the requirements of geodesy, and generally inferior to the equipments of the geodetic surveys then in progress in Europe. He therefore proceeded to Europe to study the procedure of the English and French surveys, and also to obtain a supply of new instruments of the latest and most improved forms. The Court of Directors of the Honourable East India Company accorded a most liberal assent to all his proposals, and gave him *carte blanche* to provide himself with whatever he considered desirable to satisfy all the requirements of science.

Everest returned to India with his new instrumental equipment in 1830, a year that marks the transition of the character of the operation from an order of accuracy which was sufficient as a basis for the graphical delineation of a comparatively small portion of the earth's surface, to the higher precision and refinement which modern geodesists have deemed essentially necessary for the determination of the figure and dimensions of the earth as a whole.

He immediately introduced an important modification of the general design of the principal triangulation, which up to that time had been thrown as a network over the country on either side of the Great Arc, as in the English survey and many others; but he abandoned this method, and, adopting that of the French survey instead, he devised a system of meridional chains to be carried at intervals of about 1 degree apart, and tied together by longitudinal chains at intervals of about 5 degrees, the whole forming, from its resemblance to the homely culinary utensil with which we are all familiar, what has been called the gridiron system in contradistinction to the network. The entire triangulation was to rest on base-lines to be measured with the new Colby apparatus of compensation bars and microscopes which had been constructed to supersede the measuring chain the Emperor of China had rejected; the base-lines were to be placed at the intersections of the longitudinal chains of triangles with the central meridional or axial chain, and also at the further angles of the gridirons on each side. Latitudes were to be measured at certain of the stations of the central chain, with new astronomical circles in place of the old zenith sector, to give the required meridional arcs of amplitude. Two radical improvements on all previous procedure were introduced in the measurement of the principal angles, one affecting the observations, the other the objects observed. The great theodolites were manipulated in such a manner as not merely to reduce the effects of accidental errors by numerous repetitions in the usual way, but absolutely to eliminate all periodic errors of graduation by systematic changes of the position of the azimuthal circle relatively to the telescope, in the course of the complete series of measures of every angle. The objects formerly observed had been cairns of stones or other opaque signals; for these Everest substituted luminous signals, lamps by night, and, by day, heliotropes which were manipulated to reflect the sun's rays through diaphragms of small aperture, in pencils appearing like bright stars, and capable of penetrating a dense atmosphere through which distant opaque objects could not be seen.

Everest's programme of procedure furnished the guiding principles on which the operations were carried out during the period of half a century which intervened between their commencement under his superintendence and the completion of the principal triangulation under myself. The external chains have necessarily been taken along the winding course of the frontier and coast lines instead of the direct and more symmetrical lines of the meridians and the parallels of latitude. The number of the internal meridional chains has latterly been diminished by widening the spaces between them, and in two instances a principal chain has been dispensed with because, before it could be taken in hand, a good secondary triangulation had been carried over the area for which it was intended to provide. But these are departures from the letter rather than the spirit of Everest's programme which has been faithfully followed throughout, first by his immediate successor, Sir Andrew Waugh, and afterwards by myself, thus affording an instance of the impress of a single mind on the work of half a century which is probably unique in the annals of India; for there, as is well known, changes of personal administration are frequent, and are not uncommonly followed by changes of procedure.

The physical features of a country necessarily exercise a considerable influence on the operations of any survey that may be carried over it, and more particularly on those of a geodetic survey, of which no portion is allowed to fall below a certain standard of precision. Every variety of feature, of scenery, and of climate that is to be met with anywhere on the earth's surface between the equator and the arctic regions has its analogue between the highlands of Central Asia and the ocean, which define the limits of the area covered by the Indian survey. Thus in some parts the operations were accomplished with ease, celerity, and enjoyment, while in others they were very difficult and slow of progress, always entailing great exposure, and at times very deadly. In an open country, dotted with hills and commanding eminences, they advanced as on velvet; in close country, forest-clad or covered with other obstacles to distant vision, they were greatly retarded, for there it became necessary either to raise the stations to a sufficient height to overlook all surrounding obstacles, or to render them mutually visible by clearing the lines between them; and both these processes are more or less tedious and costly. There are many tracts of forests and jungle which greatly impeded the operations, not merely because of the physical difficulties they presented, but because they teemed with malaria, and were very deadly during the greater portion of the year, and more particularly immediately after the rainy seasons, when the

atmosphere is usually clearest and most favorable for distant observations. At first tracts of forest, covering extensive plains, were considered impracticable; thus Lambton carried his network over the open country, and stopped it whenever it reached a great plain covered with forest and devoid of hills; but Everest's system would not permit of any break of continuity, nor the abandonment of any chain which was required to complete a gridiron; it has been carried out in all its integrity, often with much sacrifice of life, but never with any shrinking on the part of the survey officers from carrying out what it had become a point of honor with them to accomplish, and the accomplishment of which the Government had come to regard as a matter of course. We have already seen how the progress of Everest's first chain of triangles was suddenly arrested because he and all his people were struck down by malaria in the pestilential regions of the Godavery basin. That chain remained untouched for fifty years; it was then resumed and completed, but with the loss of the executive officer, Mr. George Shelverton, who succumbed when he had not yet reached, but was in sight of, the east coast line, the goal towards which his labors were directed.

(TO BE CONTINUED).

The Deepest Fresh-Water Lake in America.

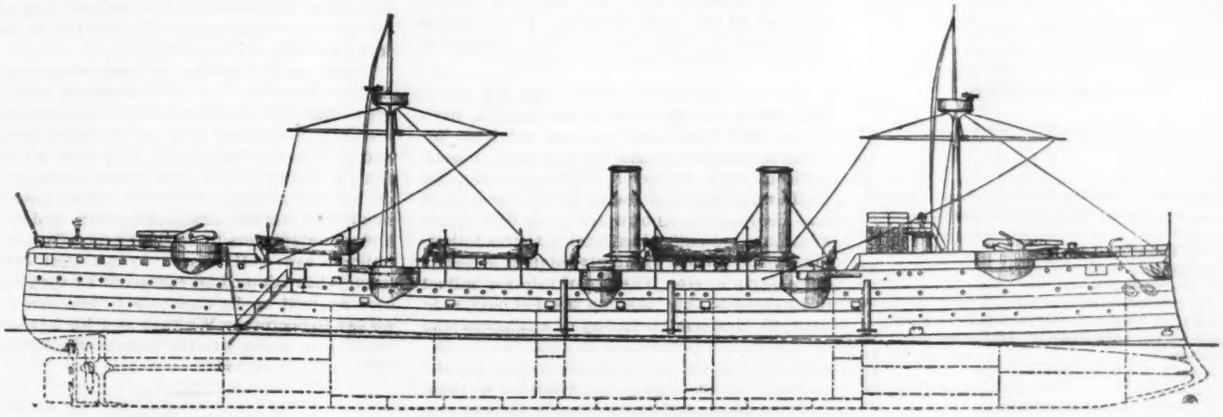
Capt. C. E. Dutton, of the U. S. geological survey, has been investigating Crater Lake in Oregon under exceedingly difficult conditions. The lake is almost inaccessible, and the boats used were hauled 100 miles by teams and then dragged by soldiers to the cliffs above and lowered by ropes 900 feet below. The soundings already taken, about 160 in all, show two large submerged cinder cones 800 and 1,200 feet high respectively with the rest of the bottom flat. The greatest depth attained was 2,005 feet.

U. S. Twin-Screw Steel Cruiser.

Length over all, 335 feet; beam extreme, 48 feet 8 inches; draft, mean, 19 feet 6 inches; load displacement, 4,413 tons; I. H. P. 10,500, forced combustion; twin screws; estimated speed, 19 knots.

The ship has two military masts; no sail power except stormsail. Coal capacity about 900 tons. Complement of men is 320. The main battery consists for four 8-inch and six 6-inch breech-loading rifles. The secondary battery 8 97-m.m. single shot Hotchkiss guns, 2 37-m.m. revolver machine guns and one short Gatling.

The hull will be constructed of steel throughout with double bottom running the entire length of the machinery space, or 150 feet



U. S. 4000-ton Cruiser: Longitudinal Elevation.

Throughout the length of the double bottom the ship is constructed on the bracket system or combination of the longitudinal and transverse system. Before and abaft the double bottom the framing is of Z-bars; the frames in the double bottom are spaced 48 inches between centers; before and abaft these points the spacing is 36 inches.

The outer plating varies from 30 pounds to 17 1-2 pounds, the ordinary weight being 20 pounds per square foot.

The machinery, magazines, shell rooms, torpedo rooms and steering gear are placed below an armored deck, which is 4 inches thick on its sloping sides, and 2 1-2 inches on the horizontal part amidships. The outer edge of this deck is 4 feet below the load line, rising to one foot above the load line at the horizontal part amidships. All the openings in this deck to machinery spaces, magazines, shell rooms, &c., are protected by coffer-dams. Above the protective deck the machinery is still further protected by side belts of coal 10 feet in thickness, averaging 8 feet in depth, extending from the skin of the vessel inboard; while below this deck a similar belt is provided 7 feet in thickness.

The vessel is what is called a poop and forecastle decked ship with open gun-deck. The battery will be mounted in sponsons on central pivot carriages supporting segmental shields two inches in thickness; two 8-inch guns on the poop; two 8-inch guns on the forecastle decks, with the 6-inch guns mounted in the intervening space on the gun-deck. Two 8-inch guns and two 6-inch guns will concentrate within 400 feet of bow or stern, while either 6-inch broadside can be concentrated within 100 feet of the ship's side.

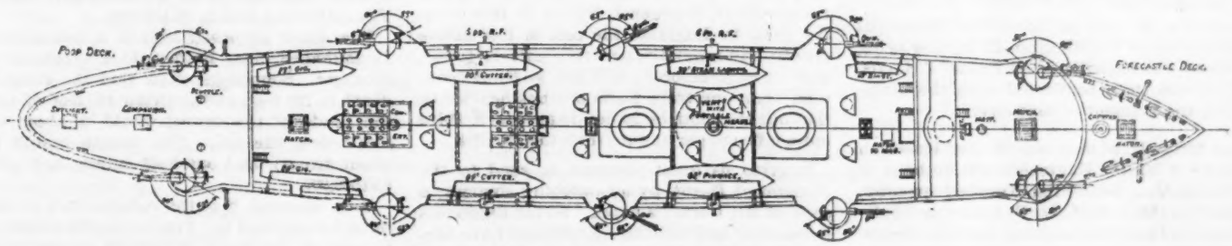
The vessel will be provided with five above-water torpedo launching tubes, electric search-lights, incandescent lighting apparatus for lighting the ship, and a complete system of exhaust ventilation for living spaces in connection with the system for forced combustion.

The protective deck will be carried down to strengthen a ram-shaped bow, which will be thoroughly stiffened and strengthened for ramming purposes.

The hull will be divided into numerous water-tight compartments by means of longitudinal and transverse bulkheads.

The motive power will be derived from two sets (each in a water-tight compartment) of triple expansion engines in connection with four double-ended boilers about fourteen feet in diameter.

The engines will be capable of developing 10,500 I. H. P. with forced draft.—*Army and Navy Register.*



U. S. 4000-ton Cruiser: deck plan.

To Develope the Water-power of Niagara.—A company of capitalists is said to have been organized and incorporated as the Niagara River Hydraulic Tunnel and Sewer Co. with the purpose of developing the water power at Niagara Falls at an estimated expense of $3,000,000. The company proposes to run a tunnel from a point below the falls to another one mile above, with a total head of 120 feet. The plan includes a site for 238 mills of 500 horse-power each, or 119,000 horse-power in all, as laid down by Thomas Evershed the engineer. Sufficient land is said to be already secured.

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THE data for the paper on the Municipal Engineering of Washington, D. C., now being published, was contributed by Frank P. Davis, C. E., at the time connected with the Engineering Department of that city.

THE forty-sixth meeting of the American Institute of Mining Engineers will be held at St. Louis, Mo., beginning Tuesday evening, October 12, 1886. Prof. W. B. Potter is Chairman of the Local Committee, and the Secretary, to whom all communications concerning arrangements, rooms, etc., should be addressed is Mr. Eliot C. Jewett, P. O. Box 576, St. Louis. The office of the Local Committee is at No. 214 Olive street.

The following programme is provisionally announced:

Sessions on Tuesday evening and Wednesday morning, afternoon and evening.

Thursday, excursion to St. Joseph and Desloges Lead Mines and Works, Pilot Knob and Iron Mountain.

Friday, visit to the Exposition; drive to Cheltenham Smelting and Refining Works and Fire-brick manufactories, and to public parks; subscription dinner in the evening.

Saturday, river excursion to Carondelet and Crystal Plate Glass Works, thirty-five miles from St. Louis.

In addition to these excursions, arrangements will be made for the accommodation of members desiring to visit other places of interest. Particulars will be given in the programme of the Local Committee.

THE English *Mechanical World* takes exception to our assertion that there are not in all England 439 miles of road in as good line and surface as are found on the Pennsylvania road between Jersey City and Pittsburg. Saying "this is clearly an oversight; counting up a total of 3,000 miles "on all of which the excellence of road is not exceeded by any piece of line either in America or elsewhere, and until something better is produced in the means of supporting rails than has hitherto been produced, we fancy it is about impossible to improve on an English first-class road."

It is difficult for an American traveler to judge of the line and surface of an English road, for the construction of the cars is such that it is impossible to look back to see the track and the reliability of the usual test of writing standing with stiff knees, is greatly vitiated by the rigid character of the rolling stock and its consequent rather bumptious method of getting over the "metals."

Our contemporary's fancy that it is about impossible to improve on an English first-class road would carry greater weight if fortified by either reasons for his fancy or comparisons with roads of other countries, and while we admit that the personal equation in any comparison known to us is difficult to eliminate, we call his attention to the following considerations which are thought to justify our assertion, viz.: The use of inferior ballast in England to that used on the Pennsylvania road, the uniform testimony of engineers who have obtained permission to walk over an English road, or who have, like the writer, had the courtesy of an engine ride extended to them that the alignment and surface is not as good, particularly the first, as on many American roads, and lastly the absence of claims on the part of English engineers, who have traveled on our trunk lines, that their trackmen keep their roads in better order than ours.

As bearing on the comparative surface in which the tracks of the two countries are kept, we beg to refer to Mr. Dorsey's table No. 45, as printed in our issue for July 10th, showing that while the cost of maintenance of way, per train mile, is, in general, higher in this country than in England, the cost of locomotive repairs and renewals, per train mile, is lower, and our contemporary will not, we think, contend that our train loads are not heavier or that our locomotives do not do at least a third more mileage per annum than the English.

It gives us great pleasure to send to the *Mechanical World*, by an outgoing steamer, a copy of Mr. Dorsey's paper. So far England's locomotive and railroading interests have produced no champion to take up the glove so liberally dispersed throughout England, and Mr. Dorsey's effort to add to the world's knowledge of railroading by a comparison of the views of those most conversant with the subject has been like the handle of a jug—entirely on one side.

For the reasons above recited we do not think our assertion was an oversight and cannot accede to the invitation to revise it without further testimony; but we earnestly invite the *Mechanical World* to read Mr. Dorsey's statements carefully and point out the errors either in data or the deductions drawn therefrom, for if England could bring her locomotive service to the economy and efficiency obtained in this country, the vast saving that would be accomplished thereby could not fail to be of great benefit to a country as closely connected by mutual services as this is to England and though our train service costs but a moiety of what it did fifteen years ago, we would be glad to again divide the cost by two.

Let us Model our own War-Ships.

We are not surprised at the outspoken indignation of American naval officers and marine architects concerning the conduct of Secretary Whitney in buying designs for the new American war-ships from nations across the sea. The plans for the 4,000-ton cruisers came from England, and he now proposes to model the 6,000-ton ships after other foreign types, or at least is about to invite proposals from abroad.

Time was when America set the fashions in this direction; her yachts still hold the America's cup won in 1851, and such steamships as our crippling legislation permit us to build are regarded as the full equals if not the superiors of vessels of similar tonnage anywhere in the world. When the emergency arose in 1861 we designed war ships that revolutionized naval architecture everywhere else, and our guns then made were the heaviest in calibre and weight of shot existing.

It does not follow that because we have not built modern iron-clads of the latest English types that we can not do it. With superior metal in abundance and an inventive talent and mechanical and naval skill that all nations acknowledge, we can doubtless improve on foreign models—if our American government will but encourage American engineers and manufacturers to do their best. Our shipbuilders are well posted in all that other nations have done, and can profit by their success as well as by their costly blunders; so we say to Secretary Whitney and his advisory board, give Americans the chance which rightfully is theirs already.

Submarine Tunnels.

Very little has been heard of subaqueous tunnels since the suspension of work on our Hudson river tunnel and the refusal of the English Parliament to allow further progress on the Dover tunnel: lately, two have been projected, one between Sweden and Denmark, under the sound between Copenhagen and Nulmo in Sweden, which is to have a total length of seven and one-half miles. The estimated cost is $6,000,000.

The other proposed tunnel is to run from Donaghadee, near Belfast, to Portpatrick in Scotland. Soundings show that the greatest depth is 780 feet, and allowing 100 feet of roof the grade of the tunnel would be about 900 feet below the sea. The length would be about twenty and one-half miles, and cost $30,000,000.

It is claimed that the construction of this tunnel would lead the Trans-Atlantic steamers to land at the north of Ireland instead of at Queenstown as at present, but until Ireland has something besides agricultural products to send to England, it will never be built unless for political reasons.

The Poughkeepsie Bridge.

The scheme for bridging the Hudson river at Poughkeepsie, practically lying dormant since 1871, has been again resurrected with every promise of immediate completion. Its purpose is to connect the railway systems of New England with the coal fields and iron and slate industries of Pennsylvania and the Middle States generally.

J. Edgar Thompson, formerly President of the Penna. R. R. Co., was the parent of the scheme and is said to have subscribed $1,000,000 to carry it out; but with two pier foundations about completed the work was abandoned.

The present syndicate is said to have paid $500,000 for the original charter through the

agency of Arthur, Knevals & Ransom, the attorneys of the old company. This charter has been extended and a contract has been signed with the Union Bridge Company of New York, to construct and complete the bridge within fourteen months.

The bridge is to be of steel with five main spans of 525 feet each, "two of these to be on the cantilever principle." The masonry piers will rise 30 feet above the water and on them will rise steel towers to a height of 135 feet above water, supporting the bridge trusses, which will be 65 feet deep. The bridge is designed for a double-track railway on deck and will have a wide carriageway beneath, or through the trusses. The bridge proper is to cost $2,228,000, and the approaches about $2,000,000 more. These approaches will be made up, on the west side, of three spans of 80 feet each and on the east, of a viaduct 2,000 feet long. The President of the bridge company is Mr. Watson Van Benthuysen, of New Orleans; P. P. Dickinson, we believe, is still chief engineer.

The foundations present considerable difficulty as to depth of water and character of material beneath. The water is from 50 to 60 feet deep, with a bed beneath of 20 feet of sediment and mud, 10 to 40 feet of blue clay, 6 to 10 feet of sand and 10 to 15 feet of coarse gravel with boulders overlying the rock, which is at a depth of 119 to 145 feet below the water surface.

The pier foundations now in place are open timber caissons filled with concrete and rest upon the gravel stratum. The caissons are 60 feet by 100 feet and are built of yellow pine and white hemlock, 12 inches square. They are divided by transverse and longitudinal walls into twelve compartments arranged with cutting edges beneath, and sinking pockets filled with concrete over the outside and cutting-edges. The material was removed from these compartments by the aid of clam-shell dredges, the sinking being controlled by the manner in which the various compartments were dredged out. The concrete was deposited with similar dredges in masses of 4 or 5 cubic yards at a time. The caissons will average 2,500,000 B. M. each of timber and 350 tons of wrought-iron.

The design for the open caissons is claimed for W. G. Coolidge, formerly of the American Bridge Co.; but we are credibly informed that the original plan was suggested by a Mr. O'Brien, a civil engineer long connected with the Adirondack R. R. Co. We cannot say what plan will be pursued by the company now in control for sinking the remaining piers.

Bridging the Hudson.

The ressurrection of the Poughkeepsie bridge project seems to have suddenly awakened the promoters of rival schemes. The Storm King bridge again comes to the fore with the reiterated announcement that the Phœnix Bridge works has the contract for its construction at $3,000,000 in stock and $6,000,000 in five per cent. gold bonds; beyond this statement we have nothing definite.

A third bridge spoken of is that at Peekskill, a point that has been under investigation for some years past. The old charter of the Hudson Suspension Bridge and New England Railway Company is said to have been availed of as a basis for proceedings at this point; and the advantages of the site are supposed to lie in the ample track room obtainable on the east side of the river.

The Peekskill bridge is to cost $10,000,000, and W. C. Hurd is the President of the Company. The plan of the bridge, as at present published, includes a suspension bridge of 1600 feet clear and a total length of 3,200 feet. The road bed is to be 193 feet above the river surface, and the towers will be 310 feet high. The bridge is to carry two railway tracks; and the weight of steel and iron in the structure is estimated at 26,435 tons and the masonry at 258,165 cubic yards.

The Canal Convention at Syracuse.

The Canal Union met on the 25th ult. with Hon. O. B. Potter as temporary chairman. The Buffalo delegation advocated Congressman Webber's bill appropriating $5,000,000 to the improvement of the Erie canal. But the New York delegates objected to any goverment aid, nominally through fear that the contract would pass from the State. In the election for permanent chairman, Mr. Potter, who opposed federal aid, was defeated by Mr. DeWitt Clinton who advocated the enlargement of the canal by the State, to be followed by a demand upon the United States for reimbursements for the expenditures.

In answer to the scheme laid down in the opening remarks of Mr. Clinton, the Committee on Resolutions resolved, in effect, as follows; that it is the duty of the State to at once put the canals in the highest possible state of efficiency; that they be made available for boats of the largest capacity, and that the locks be lengthened and the channel deepened on the Oswego and Champlain canals.

Congressman Webber, in defense of his bill, denied that the State would lose control by accepting government aid, and thought that the Western congressman could be made to see a good investment of Western capital in such a scheme. Congressman Burleigh, chairman of the Committee on Resolutions, stated that the railways of the United States would strongly oppose an appropriation of money by the government for the improvement of the Erie canal, thus strongly endorsing Mr. Thurber's views quoted in our issue of August 14.

The resolutions as framed were finally adopted, with a further resolution pledging candidates for the Legislature to appropriate $5,000,000 for the canals next year.

There is probably no more effective way of preventing for the next twenty or thirty years the enlargement and improvement of the Erie canal to its greatest capacity than by this present scheme of appropriating money to lengthen the present locks without increasing either their width or depth. It is to be doubted if any strenuous opposition will be made to the plan either by the railways most interested or by their newspapers.

The Mechanical Science Section of the American Association for the Advancement of Science.

At the Buffalo meeting of the association, on Aug. 19, Octave Chanute, C. E., vice president of the mechanical science section, delivered an interesting address on the progress of mechanical science and the field which was laid open to the members of the association.

Mr. Chanute, by well selected examples, called the attention of engineers and others to the gradual evolution of an invention by the progress of exclusion or by finding out first what would not do. The earlier inventors would have achieved more rapid and greater results had they had the benefit of a larger range of scientific experiment and advice. The steamboat, locomotive, telegraph, sewing machine etc., of to-day are the results of years of trial and rejection. He laid down the rule that "the basis of sucess lay in a thorough acquaintance with what has been done before and in setting about improvements in a thoroughly scientific way."

The author did not exactly believe in the exclusion of speculative papers and discussions from the proceedings of all technical societies. He believed that the busy men who are developing this country should keep up with discovery before it is reduced to practical account, and that personal sympathy and contact with men of science was a thing nothing could replace.

The substance of Mr. Chanute's address was to encourage engineers and all other practical men to bring to the association accounts of what they have done and hope to do, and especially of their failures and the reasons why they failed. Speculative papers, provided they had a sound basis and were close to the facts, might well be allowed at such meetings, for there was no telling how soon these probabilities might become actual facts.

The chairman for the Mechanical Science and Engineering section for the next meeting of the Association is Mr. Eckley B. Coxe.

The Earthquake.

The earthquake of Tuesday now stands on record as the most violent in action of any similar movement of the earth's crust, east of the Pacific coast, since 1811, when the region for 300 miles south of the mouth of the Ohio river, rose and fell in great undulations, lakes were formed and again drained and the surface near New Madrid, in Missouri, burst open and mud and water spouted forth. This convulsion was remarkable for the incessant quaking of the ground in that region for several successive months.

The short time that has elapsed since the destruction at Charleston has, as yet, prevented the mapping out of the area of the United States effected, but the data already indicates that the disturbance was felt over a very unusual extent of country, it being one of the greatest in this respect on record. Mr. Mendenhall, of the signal service, states that on a globe 10 inches in diameter the area of an earthquake can usually be covered with the tip of the little finger, but this one covers nearly half of a continent.

The theory advanced by Prof. Powell, of the U. S. Geological Survey, that the late shaking up is due to a geological line of weakness, or a fault in the earth's crust, extending along the Atlantic coast from about the region of Charleston to Troy, in New York, is not reassuring to citizens of New York. But while this line of displacement has been a subject of investigation for some years past by the geological survey, and is undoubtedly represented by a general seaward tilting of the surface, it must be remembered that a change of level, slight but apparent, is taking place constantly along our coast, and in fact over the entire surface of the globe at some point or other. Experts estimate that about one thousand earthquake shocks occur daily in different parts of the world, but few are even felt.

The generally accepted theory of earthquakes is that the molten interior of the earth is constantly losing heat in a variety of ways, by being conveyed to the surface in hot springs, by eruptions of lava, escape of gases, etc. The shrinking in volume which follows this slow cooling process must, sooner or later, cause the solid exterior crust to follow the laws of gravitation and to settle down and conform in outline to the lesser magnitude. Other agencies modify this shrinking; the rains and rivers of a continent displace great volumes of material, unloading the higher grounds and gradually depositing greater loads along the shores of seas. This action may in time have an effect

upon the plastic material beneath and in places force mud and water or lava to the surface. The sudden inrush of water on to heated surfaces or the release of pent-up gases are other natural phenomena that, carried on on Nature's grand scale, would be productive of great convulsions of the surface overlying such powerful agents of destruction. The electrical phenomena noted are generally regarded as an effect rather than a cause; and they are charged to the change in atmospheric conditions. The eccentricity of the compass needle was noted during the late disturbance.

The sudden resumption of work by one of the long dormant geysers of the Yellowstone region, and the uncontrollable outburst of an artesian well in Iowa, all within a very short interval, have been generally connected with the late earth disturbance. The geyser action may be so accounted for; as that region is undoubtedly one of the safety valves of the inner earth on this continent; and as we really do not yet fully understand the causes nor can account for all the eccentricities of the hot springs of the Yellowstone Park, it would be unsafe to totally deny the assertion of a sequence in action. But the powerful flow of the artesian well of Belleplaine can be accounted for in many other ways than by a sudden sinking of a portion of the earth's crust, and while it is a coincidence we see no reason for any intimate connection between the phenomena.

While an earthquake is an interesting subject of study, to those removed from its immediate neighborhood, its re-occurrence as to location can be theorized upon; but it is just about as safe in the end to guess at it. We can neither foretell the next one by time or locality, unless local disturbances of some kind give us the hint. We have the satisfac- of knowing, however, that the crust under us is always becoming thicker and hence somewhat stronger; and when a section of country seeks a more stable foundation by setling down upon an uneasy base, it is likely to remain at rest for some time to come.

While on the subject of earthquakes it might be well to tell of an expedient adopted by the residents of the New Madrid region to prevent or lessen the danger of being swallowed up in the fissures which were then forming for some time. We are informed by one who learned it on the spot that as soon as the general direction of these cracks was ascertained, the people felled forest trees so as to fall at right angles to this direction and located themselves on the tree trunks. This seems to us to have been about as sensible a course to pursue, under the circumstances, as could have been desired. Unfortunately trees are scarce in New York and our tall buildings will hardly answer the same purpose.

Water Power of the United States.

A valuable work has just made its appearance in the shape of Reports on the Water Power of the United States, compiled for the Tenth United States Census by Prof. W. P. Trowbridge as chief special agent, assisted by Prof. Geo. F. Swain, Dwight Porter and James L. Greenleaf, special agents.

The report is arranged by drainage basins as follows:—Eastern New England, Long Island Sound, Hudson River and Lake George, Lake Ontario and New York State canals, Lakes Huron and Erie and Niagara Falls and river, Middle Atlantic water-shed, Southern Atlantic water-shed, Eastern Gulf slope, the Northwest, Mississippi river and some of its tributaries, West Mississippi Ohio river and Ohio State canals and the water supply of certain cities and towns. Under these heads the water-powers contained in the areas considered are described at length, with illustrations and statistics of manufacturing, estimates of power, cost of power, water privileges, etc. The illustrations comprise maps of the drainage basins and water-powers, designs for dams, views of mills, sections of canals, etc.

This volumnious report, upon a subject never before arranged in intelligent and accessible shape, contains general and specific information of the highest public value and interest. According to the returns of 1880 there were in the United States 55,404 water wheels, utilizing a total power of 1,225,379 horse-power, or nearly 36 per cent. of the total power used for manufacturing purposes in the whole country. Prof. Swain, in his general introduction, says that this country stands pre-eminent both in the aggregate power employed, and in the number and importance of its improved rivers. But in treating of the vast reserve of power yet untouched, the same authority roughly estimates the theoretical power of our streams, at an average through the year, as reaching the astounding figures of 200 million horse-power; the portion of this now used amounts to only about one-half of 1 per cent.

But when the power generated in the lower or navigable portion of rivers, and in other portions where the slope is small is discarded as unavailable, and other deductions made for variable flow, excessive slope, or topographical configuration, it is evident that the practically available power of the country will be but an exceedingly small fraction of the estimated theoretical power above. As an example, the theoretical power of the Mississippi river alone, from Cairo down, where development of power is impossible, is 13 million horse-power.

In the decade 1870 to 1880, the water-power has increased, in number of water-wheels 8.60 per cent., and in horse-power, 8.40 per cent. Within the same period the number of steam engines has increased 40.54 per cent., and steam horse-power, 79.77 per cent. The total steam and water-power utilized in 1880 was equivalent to 3,410,837 horse-power, a gain of 45.38 per cent. over 1870.

From the tabular returns of steam and water-power, by States, we find that Pennsylvania stands first in power used in manufactures, with 15.02 per cent. of the total for the United States. New York is second with 13.31 per cent.; Massachusetts third with 9.08 per cent., and Ohio fourth with 7.66 per cent, In amount of water-power used, New York is first with 17.90 per cent.; Massachusetts 11.29; Pennsylvania, 9; and Maine is fourth with 6.51 per cent. With steam power alone, Pennsylvania is again first with 18.40 per cent. of the whole, then comes New York, 10.74; Ohio, 10.18, and Massachusetts with 7.84 per cent.

In comparing the amount of water power used with the area of the States per square mile, we find that little Rhode Island is first, with 20.5 horse power per square mile as against 4.61 horse power for New York.

In the distribution of power, the Northern Atlantic States, from Maine to and including Pennsylvania and New Jersey, contain 53.05 per cent. of all the utilized power steam and water; the water power alone reaching 63.62 per cent. of the whole. The Northern Central or Middle States, including the States north of Kentucky, Arkansas, Indian Territory, and East of Montana, Wyoming, Colorado and New Mexico, contain 30.16 per cent. of all the steam and water power used, and 18.67 per cent. of the water-power. This leaves only 16.79 per cent. of steam, and water as utilized in the Southern Atlantic, Southern Central and Western or Pacific slope States. Of the water-power alone 63.62 per cent., or nearly two-thirds, is in the Northern Atlantic States; New England reporting 34.51 per cent.

The manufacture of flouring and grist-mill product consumes 38.35 per cent. of the total water-power of the United States. Next comes lumber mills, with 22.74 per cent. and then cotton goods and paper, with 12.14 and 7.15 per cent. respectively.

A tabular statement of the slopes of the principal streams flowing into the Atlantic and the Eastern Gulf shows that the slope of the streams is pretty much the same per mile from the Merrimack to the Chattahoochee; the average slope of twenty-one main streams is 5.4 feet per mile, with the Susquehanna the flattest at 2.8 per mile, and the Hudson river the steepest at 10 feet per mile.

Considering the volume of water carried by the streams in question, it is clearly shown in this report that as we proceed southward from New England the streams become in general more variable in flow, the freshets more violent and the dry season flow smaller. Prof. Swain charges these conditions to three principal causes. First to the absence of large lakes or artificial storage reservoirs to regulate the flow south of the Delaware; second; the topography of the drainage basins of many streams in the Middle and Southern States is such as to produce variable flow, and third, the rainfall in New England and in parts of the middle States is distributed with a greater quantity in summer and autumn than in winter and spring, thus giving an increased supply to meet the evaporation in the summer months. In the States south of Pennsylvania and Maryland the reverse of the last condition is true, rendering the streams more variable.

The slope of some of the southern tributatries of the Ohio river is very light, ranging from 0.41 feet per mile for the Green river to 2.84 feet for the Allegheny as a maximum. The falls in these streams generally take the form of long shoals. As an example, however, of the rapidity which some of these rivers descend from their elevated sources to the gentle slope of their subsequent course, Mr. Dwight Porter mentions that the Cheat river, in West Virginia, falls 2,400 feet in the last eighty miles of its way to the Monongahela, while the latter river descends but 75 feet in the ninety miles between the mouth of the Cheat and Pittsburg. The northern tributaries of the Ohio have usually steeper slopes, but the average is far below the rivers on the upper Atlantic coast. The Ohio river itself, from Pittsburg to its mouth, a distance of 967 miles, falls 430 feet, or an average of 0.44 feet per mile. Louisville, with a fall of 26 feet in two miles (at low water) offers the only opportunity for the development of water-power and that not economically.

Among the entirely undeveloped areas of water-power, the southern shore of Lake Superior offers a water-shed lying at an elevation of from 600 to 1,050 feet above the lake and only about thirty miles distant. The western and northern shores of this lake have also a still better storage of power, with an elevation of 1,000 feet and a distance of but eight or nine miles from the lake. The St. Louis river, at the western extremity of the lake, drains over 3,000 square miles and descends 456 feet in the last eleven miles of its course, giving rise to a magnificient water-power, estimated by Mr. Greenleaf at nearly 50,000 horse-power at ordinary low water. The rainfall over the Lake Superior drainage area is from 30 to 35 inches, favorably distributed.

The upper Mississippi, from its extreme

sources to Saint Paul, 500 miles by the river, falls 1,000 feet. But while important powers exist, they are concentrated at certain points; the minimum theoretical power at Minneapolis being stated at 25,000 horse-power.

The western tributaries of the Mississippi are very unfavorable for the development of power. There are no lakes of importance and the rivers do not cut down into the rocks underlying the drift formation of the prairies: hence there are no falls but simply a bed of mud, sand and gravel of very uniform slope. Lying in the heart of a great continent the winds are almost drained of all moisture before they reach even the outer confines of this region. With 40.7 inches at St. Louis the rainfall decreases as we go west until at Fort Bridger, in Wyoming, it is but 8.4 inches; and it is less than 20 inches for most points west of the 99th meridian. The Missouri river itself falls 2,464 feet in the 2,644 miles of its course from Fort Benton, but is navigable to that point; thirty-five miles above this are the falls of the Missouri, a descent of 161 feet in nine miles. There is no power utilized on the river.

The tributaries of the Mississippi from eastern Iowa furnish numerous small water-powers, though none exceed individually more than about 1,200 horse-power. The general slope of this country is at the rate of about 4.5 feet per mile towards the southeast, and the general slopes of the streams range from 1.84 to 3.83 feet per mile.

The Arkansas River, from its source to Pueblo, Colorado, averages 34.11 feet per mile; but with a drainage area of 160,000 square miles to its mouth, it runs almost dry at times and the ordinary low water discharge is but 0.019 cubic feet per second, per square mile. The absence of storage facilities, and the fact of more rain falling in summer than at any other season, explains this condition of affairs. In the upper 120 miles, the river falls 40 feet per mile, then flattens out to 8 feet per mile for 500 or 600 miles, and at 150 miles above its mouth, its slope is only 0.46 feet per mile.

The water-power of Niagara Falls was made an especial study by Mr. Greenleaf. In its short course of 37 miles the Niagara river descends 333 feet to Lake Ontario with a vertical plunge of 160 feet at the falls, and discharges a volume of water nearly half as great as the Mississippi river.

According to gaugings made by the U. S. Engineers, the average flow of the river above the falls, is ten million cubic feet per minute, or 166,600 cubic feet per second. From Buffalo to 3 miles above the falls, the river descends 20 feet; from this point to the brink of the falls, it descends about 53 feet in four terraces. The American fall (Blackwell's survey, 1842) is 167.7 feet high, and the Horseshoe fall is 158.5 feet high; from the foot of the falls to Lewiston, the descent is 98 feet, and from there to Lake Ontario, 2 feet.

Mr. Greenleaf figures the theoretical power of the Niagara river, for its total fall of 333 feet, at 6,294,000 horse-power. Of this amount, all but 400,000 is between the head of the rapids and the foot of the gorge at Lewiston; and 4,000,000 are expended within a distance of less than a mile at the falls. The Niagara river is very steady in its flow as a rule, but the effect of wind on Lake Erie has been known to cause a fluctuation of as much as 33 per cent. in 48 hours; the ordinary variation in surface is about one foot. The present power utilized by the wheels now erected is 5,200 horse-power.

The report is a folio of nearly 900 pages, and we must refer our readers to the book itself, for the interesting and important detail of individual powers, and the various capabilities of the water-sheds of the United States.

PERSONAL

CHARLES E. GOAD. Mem. Am. Soc. C. E., was married to Miss Agnes Harris, at Montreal, on August 25th.

President T. B. BLACKSTONE and General Manager McMullin of the Chicago & Alton R. R. have just returned to Chicago from a trip to Alaska.

The special committee appointed by the Cincinnati Board of Public Affairs have recommended that the salary of the city engineer be fixed at $4,000.

H. P. TOBIAS, a civil engineer in the employ of the Illinois Central R. R. Co., stationed at New Orleans, died August 25, in hospital at Louisville, Ky He was a native of Elmira, N. Y.

WILLIAM H. HOWELLS, a civil engineer who has done considerable work on the Bartholdi statue on Bedloe's Island, died on Monday last at his home, No. 51 Concord street, Brooklyn.

M. A. B. LUFFER, who has been for a long time engineer in charge of the Skinnecock Canal, Long Island, has resigned. Mr. ELLIS B. NOYES, of Bayonne, N. J., has been appointed to the place.

JAMES FLOWER of the firm of James Flower and Brothers, Detroit, died in that city on the 28th, at the age of 68. MR. FLOWER was well known throughout the entire country as a machinist and inventor, especially in the department of water works appliances.

MR. JOSEPH P. DAVIS, formerly engineer of the city of Boston, has been appointed consulting engineer of the Mass. State Board of Health, and Mr. F. P STEARNS, who has been in charge of the Moon island intercepting sewer, has been made engineer of the board. Mr. Stearns address is 13 Beacon street, Boston.

CITY OF MEXICO, Aug. 31.—A powerful company of English capitalists, with headquarters in London, has got possession of an old concession for a railroad from Tuxpan to this city, and will build a road which it is calculated will involve the expenditure of at least $25,000,000.

HENRY VILLARD is expected to put his sign out again in Wall street thirty days hence. He has rented a room on the fifth floor of the Mills Building, and will represent a syndicate of German capitalists in their American investments. It is promised by his friends that Mr. Villard will do no more railroad skyrocketing on his own account soon.

MR. A. PEHGER, C. E., of Vienna, Austria, is examining the industries of this country. He said to a Pittsburg interviewer.

"I have been astonished with the advancement of this country in engineering. In some matters we are ahead, but in others America leads. I think on the whole, though, the United States have the advantage."

H. A. HANCOX, C. E., has resigned his position on the Hudson, Mass., water-works to accept the chief-engineership of the St. John Valley & River du Loup railroad in New Brunswick. They propose to construct sixty miles at once, with a prospective extension of two hundred miles more. The part at present contemplated leaves Fredrickton, the capital of New Brunswick, and runs north on the St. John river.

CHARLES W. MEAD has accepted the position of General Manager of the Guatemala Central R. R. Co. and will have charge of the construction of that line. He recently sailed from San Francisco to take charge of the work. Mr. Mead was for some time General Superintendent of the Hannibal & St. Joseph R. R. and subsequently served on the Missouri Pacific, and Union Pacific, and as General Manager of the Northern Pacific R. R.

American Society of Civil Engineers.

A meeting of the American Society of Civil Engineers was held Wednesday evening Sept. 1, at the house of the Society, Vice President Thomas F. Rowland presiding. The Board of Direction reported the recent death of Mr. E. S. Chesbrough, past-president of the Society, and it was resolved that the customary committee be appointed to prepare a memorial.

The business of the evening was the presentation of a progress report of the Committee on the Compressive Strength of Cements and the Compression of Cements and Settlement of Masonry, by the chairman Mr. F. Collingwood. The data presented and the deductions made were interesting and important to engineers, but as the document was mainly a matter of figures we must delay any notice until we can give it in full. The session was closed by a general talk on the recent earthquake by members who had had experience in earthquake countries.

The ballot for membership taken declared the following persons elected to the several classes:

FOR MEMBERS.

JOSIAH ACKERMAN BRIGGS, formerly Assistant Engineer Water Works, Streets and Sewers, Yonkers, N. Y., Assistant Engineer Department Public Parks, New York city, in charge of Sewer construction:

CARL WALDEMAR BUCHHOLZ, formerly Assistant, Division, Resident and Constructing Engineer, Philadelphia and Reading Rd., Chief Engineer and Consulting Engineer Schuylkill River East Side Rd., now Engineer Bridges and Buildings New York, Lake Erie and Western Rd., New York City.

FRANCIS EAVE BUTTERFIELD, (Woodlawn Coll. Ins. Ala. 1865.) formerly Engineer Irrigation Works in Texas, U. S. Assistant Engineer in Texas; Assistant Engineer Mexican National Construction Co.; Assistant Superintendent Mexican National Ry.; Engineer and Superintendent Brownville and Gulf Rd.; now Assistant City Engineer, San Antonio, Texas.

ALFRED EPHER HUNT, (Mass. Inst. Tech. 1876.) formerly Chemist Bay State Iron Works, Boston; Superintendent Steel Department Nassau Iron and Steel Works; recently Superintendent and Constructing Engineer with Messrs. Park Bros & Co., Pittsburg; now member of the firm composing the Pittsburg Testing Laboratory, Mechanical, Metallurgical and Inspecting Engineers, Pittsburg, Pa.

JONES MUMFORD JACKSON, formerly Assistant Engineer, Chesapeake and Ohio Rd.; New York State Canals; on location and construction Second Avenue Line Metropolitan Elevated Rd., New York; Resident Engineer Texas and Pacific Ry., recently Engineer and Superintendent Hudson River Contracting Co. during the building of Helena Branch St. Louis, Iron Mountain and Southern Ry., Assistant Engineer Missouri Pacific Ry; now Assistant Engineer in charge Construction Memphis track St. Louis, Iron Mountain and Southern Ry., Wynne, Arkansas.

CHARLES LEONARD ROWLAND Mechanical Engineer Continental Works, Brooklyn, N. Y.

THOMAS FITCH ROWLAND Jr. (Sheffield Sci. School 1877) Mechanical Engineer Continental Works, Brooklyn, N. Y.

WILLIAM RUMBLE, formerly engaged on Erie Canal Enlargement, First Assistant Engineer and in charge of Construction Erie Canal Enlargement at Albion; laid out City of Clinton, Iowa; engaged in laying out and monumenting streets of New York; now Civil Engineer with New York Steam Co., New York City.

FRANK WOODWARD SKINNER, (Cornell University, 1879.) formerly with Pittsburg Bridge Co.; Delaware Bridge Co.; New Jersey Steel and Iron Co.; Assistant Engineer Dominion Bridge Co., Montreal; in charge inspection and construction of Bridge Work for St. Paul and Northern Pacific Ry.; now with Messrs. Buck and McNulty, Members Am. Soc. C. E. New York City.

WILLIAM JOHNSON SPROULE, (McGill University, Montreal, 1877.) formerly General Assistant Construction Toronto Water Works; Assistant Engineer Enlargement Lachine Canal; Montreal Harbor and St. Lawrence Ship Channel Improvements; Division Engineer Pittsburg, McKeesport and Youghiogheny Ry.; in charge of land Surveys in Manitoba; in charge remeasurement and classification Lake Superior Section, Canadian Pacific Ry.; now Assistant Engineer Montreal Harbor and St. Lawrence Ship Channel Improvements, Montreal, Canada.

THOMAS MANN RANDOLPH TALCOTT, formerly Assistant Engineer Richmond and Danville Rd.; Ohio and Mississippi Rd.; Vera Cruz and Mexican Rd.; Department Engineer, Aid-de-Camp and Colonel of Engineers Confederate States Army; Division Engineer Imperial Mexican Ry.; Division Engineer Chesapeake and Ohio Rd.; Engineer, Superintendent, General Superintendent and General Manager Richmond and Danville Rd.; now Vice-President and General Manager Mobile and Ohio Rd., Mobile, Ala.

FOR JUNIORS:

EDWARD LORENZO ABBOTT, (Illinois State University, 1883.) formerly engaged with Lassig & Alden, Bridge Builders, Chicago, Ill.; now Assistant Engineer for Sooysmith & Co., Engineers and Contractors, New York City.

WILLIAM CLINTON BROWN, (Cornell University, 1881.) Engineering Department of Henry R. Worthington New York City.

WILLIAM CUSHING EDES, (Mass. Inst. Tech. 1875.) Assistant Engineer Southern Pacific Rd.; now assistant to M. M. Tidd, Am. Soc. C. E., Boston, Mass.

GEORGE ROBERTSON HOOPER, (Royal Military Coll, Kingston, Canada, 1882.) Engineering Department, Canadian Pacific Ry., Montreal, Canada.

MONTGOMERY WADDELL, (Rens. Pol. 1881.) Electrician for Edison Machine Works, New York City.

Correction.

WESTERN DIVISION BOSTON WATER WORKS,
BROOKLINE, MASS., Aug. 30, 1886.

EDITOR ENGINEERING NEWS:

The mean monthly rainfall for September, p. 117, article "Rainfall and the Amount Available" was printed 5.37 inches for water supply. It should have been 3.57 inches.

Very truly,
DESMOND FITZGERALD.

Where Safety Lies in the Use of Surface Water.

In the uncertainty which prevails as to the correct hypothesis for the spread of disease from contaminated drinking water, it will be conducive to safety in practical sanitation, to recognize the existence of *living disease germs;* for the reason, that if the precautions necessary to render harmless the living germs be thoroughly carried out, there is presumable safety resulting therefrom, let what may prove ultimately to be the truth respecting the etiology of enteric diseases. No merely organic poison could withstand the treatment rendered necessary for the destruction of a living germ, while the expense attending the additional precautions needed in the latter case, will be amply repaid by the improved hygienic conditions thereby attained. It is for this reason that sanitarians are fully agreed as to the proper measures to be taken for safety, while they may differ widely as to the character of the specific poison to be combatted.

We may assume, therefore, as a "working theory," that the poison of infection from a contaminated water supply, is a living organism, or "germ," with almost unlimited powers of reproduction under favorable surroundings.

This principle being understood, I proceed to its application. The undersigned had occasion to make an official report to the New Aqueduct Commission on the proposed Quaker Bridge Dam (published in ENGINEERING NEWS, Feb. 27, 1886) and to meet some adverse criticisms which had appeared as to the hygienic conditions of the stored waters from the Croton water shed, used the following language:

"The population on the water-shed gives about eleven acres to each inhabitant, and about 120 acres to each house, and with the refuse from all animal life deposited on, or in the earth, as is customary in the country, yet Dame Nature has provided a means by which ten times this population would not poison an inhabitant of New York city fifty miles distant. Decaying vegetable matter though disagreeable, cannot be considered as noxious. Animal excretion *is* a pollution, which, but for the principle of nature alluded to, would render water gathered from any occupied land objectionable. This principle may be thus stated. The substances forming animal excreta are extremely unstable in their chemical composition, and in the presence of oxygen they are constantly tending to change; this change involving a destruction of their noxious properties by their conversion into inert harmless compounds. This change may be brought about by exposure to the atmosphere, or to the ground air in the soil or the free oxygen which waste waters contain, and were it not so, and in daily operation, the rivers of the world, washing inhabited shores, instead of being of almost universal use as potable water, would long since have been found destructive of life, so that the scattered inhabitants, together with the animals incident to rural life, have no ill effects whatever upon water draining from the surface of the earth into streams of any magnitude. But where dense settlements occur, as of towns, and human excreta, instead of being deposited in the earth and rendered subject to the action of the above natural law, is collected and discharged by drains and sewers direct into the streams, unless the volumes of the latter be very great, the water would prove prejudicial to the public health. Therefore, the draining from sewered towns should by law undergo some efficient purification before being admitted into any stream which is liable to be used for domestic purposes."

"The above refers to healthy excreta alone, which admits of ready treatment in the way of purification by combined irrigation and filtration. We hear now, however, in the progress of science, of 'disease germs,' which nothing short of some chemical agent will destroy. What and whence they are, nobody knows; but one thing is certain, if these germs are living organisms, as claimed for them, no amount of filth however concentrated, can of itself suffice to generate them, however well conditioned it may be for their subsequent development. Life can only spring from life. These germs may feed and increase through filthy surroundings, but they cannot be generated by it; and this points to the only sure method of destruction, as clearly within the province of the physicians to carry out under the authority of intelligent Health Boards."

A committee of the Union League Club, in stating their objections to the construction of the Quaker Bridge Dam, gave amongst other assertions, published and endorsed by them, a paper by a civil engineer, from which I make the following extract:

"Where a man like Pasteur or Tyndall finds the atmosphere full of life germs of fermentations, Colonel Adams has a different theory, that 'Filthy surroundings cannot generate this life.' Unfortunately experts in fermentation differ with him, and the Quaker Bridge Dam, as the constituted cesspool of the whole Croton valley, will prefer to recognize experimental laws, and ferment its enormous quota of organic matter, dying and dead accordingly and offensively."

As the writer of this extract evidently has not a very clear idea of the bearing of Tyndall's experiments and cannot understand the entire accord of all I have written, with the conclusions to which that scientist arrived, I cannot hope to enlighten him on the subject—but take this occasion of emphasizing a little more in detail, what, in the Report of January, 1886, was but little more than hinted at.

Until the later experiments by Tyndall and others, it had been claimed that spontaneous generation was a possibility, but his experiments first established the fact now recognized by all modern scientists, and stated in his own words as follows: "I affirm, that no shred of trustworthy experimental testimony exists, to prove that life in our clay has ever appeared independently of *antecedent life*" the italics are my own. I am thus assured, that no combination of matter alone, will produce a *living* germ. The touch of life is necessary to produce life. Nothing in the putrifactive process of animal decomposition, or the fermentation of vegetables (if they differ at all) will produce a *living* organism or *germ*; and so, if the seeds of disease are species of bacilli, or what not, (as is claimed by sanitarians) capable of springing into life, and with amazing powers of re-production continuing their species, the principle of life within them, came from without, whence, we know not, and it is scarcely unphilosophical to assert that we never shall know. Referring to my opening remarks as to the safety of a "working theory" for sanitarians which shall provide for the extreme case, thus embracing as well the less difficult problems, the germ theory offers itself as the only safe theory in our confessedly limited knowledge of the subject.

Parasitic life abounds on all sides; in the air we breathe, in all that we eat and drink and touch, we are constantly exposed to the receptions of germs. Bacteria and various germs can be found in all parts of the human body—in the mucous passages open to the air, in myriads on the tongue, in the tartar of the teeth, in the nose and throat, and all through the alimentary canal into which myriads are poured with our food and drink. Millions of them it is said, may find a home in the smallest drops of water, and they would pass thousands abreast through the pores of any filter adapted to the flow of water, yet this may not be attended with any marked disturbance of health, hence they cannot all be regarded necessarily as disease germs, while the secretions of the human body are in a healthy state. In the case of the typhoid poison, we know that its embryo-soil is in the mucous membrane of the alimentary canal, and fæcal matters finding their way into drinking waters, give rise to the severest form of typhoid infection; but this germ, whatever its nature, has not been obtainable for direct observations, but it is beyond doubt that *foulness*, whether of air or water, animates the poison, and favors its development. If stringent laws prevailed, making it the duty of attending physicians to see that the dejecta of patients suffering under such attacks were properly disinfected, it would matter little whether the poisonous infections were simply organic poison, or a living germ, its power for further mischief could be destroyed. Such is the treatment hinted at in my report of January, as within the reach of the local Board of Health.

Dr. Edson well says in a late article in the *Sanitarian* referring to the outbreak of typhoid in Plymouth, Penn., where it was conclusively shown that the fæcal discharge from a single typhoid patient, thrown on the banks of a reservoir when covered with snow, after a thaw, resulted in some 1200 cases of sickness in those who used the [water: "Neglect on the part of the attendant to disinfect the stools of persons suffering from infectious enteric disease, should be made a criminal offense." This neglect really means the destruction of human life by parasitic organisms which we have the power but not the will to exterminate.

The precautions to be taken to render the ordinary healthy surface drainage from farms and villages on the Croton basins entirely safe as a potable water in this city, are sufficiently indicated in the Report referred to. The basin of the Croton offers every facility for its application, and experience has demonstrated elsewhere its trustworthiness, and justifies the concluding sentence of the Report:

"That there is no danger to health now or in the hereafter in the use of impounded Croton water, which an intelligent application of the means at our disposal will not suffice to render harmless."

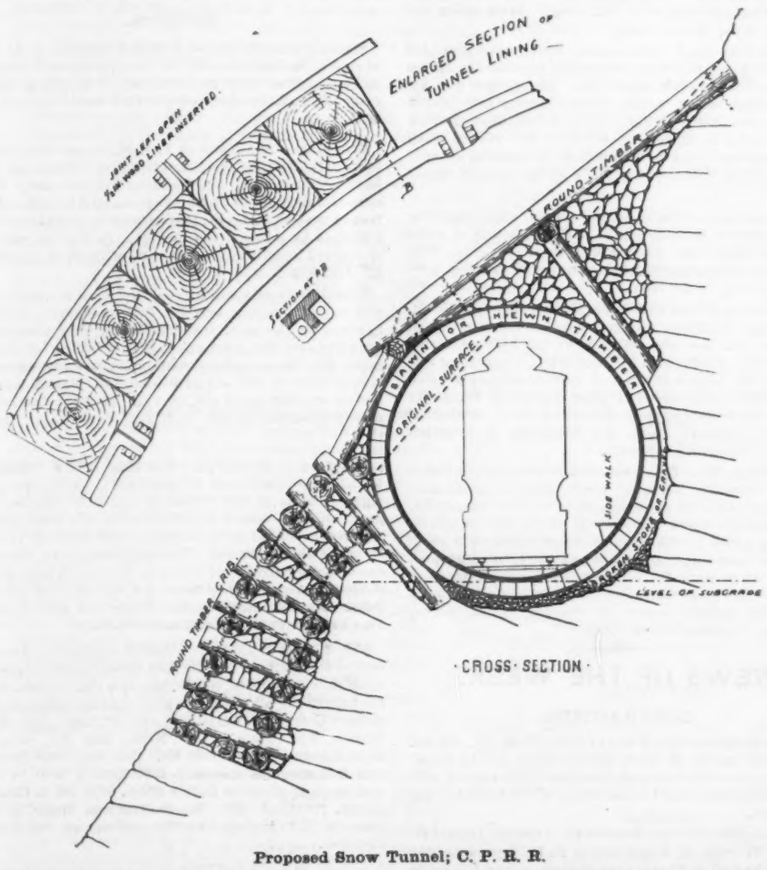
JULIUS W. ADAMS,
31 Broad Street.

CHARLESTON, W. VA.—The capital city of West Virginia will hereafter enjoy the advantages of an abundant and constant supply of pure, bright water. The water-works company some months ago contracted for a complete plant of the Hyatt system, and it is now in place and ready for work.

Proposed Snow Tunnel, Canadian Pacific R.R.

The material for the accompanying description and sketch of snow shed or tunnel on the Canadian Pacific R. R., was furnished us by Henry Purdon Bell, Mem. Am. Soc. C. E. and Mem. Inst. C. E.

The section shows a snow shed or tunnel, the special feature of which is that once covered with debris from a slide, its stability would be rather improved than otherwise. The original conception is a circle of sawn or hewn timbers cut radially and keyed by the final piece, and hooped at intervals by segmental iron rings bolted together. The outer ring is wrought-iron, and the inside ring of cast-iron; and the joints of the outside ring are left open sufficiently by the introduction of wooden fillers to permit of their tightening as the timber shrinks. It will be seen that no great structural ingenuity would be required to rebuild the tunnel in masonry or concrete, should such a measure ever be deemed advisable.



Proposed Snow Tunnel; C. P. R. R.

No dimensions are given on the original, as it was simply a plan suggested by Mr. Bell, and presented to Vice-president Van Horne, C. P. R. R., last year, for use in the Selkirk range of mountains. The facilities existing for obtaining timber in abundance and of almost any size within practicable limits, will account for the general style of the design. As the track of these mountain slides is rarely if ever, of any great width, the question of ventilation had not been considered.

Though, at the time of the submitting of this plan, Vice President Van Horne stated that the line had been so skilfully located that nothing extraordinary in the way of snow sheds would be required, it is now reported that the company is actually building sheds very similar at least to the plan of Mr. Bell. Engineers who have seen them variously describe them as follows: "a bulwark of logs enclosing a tunnel of timber;" "a timber tunnel inside a crib of logs;" "a heavy circular framework of timber with a protection of logs," etc. This looks very much as if these tunnels were being actually constructed and we should welcome a more detailed plan and description from some of our Canadian Pacific readers.

The Water Works Contractors.

Specially Reported for ENGINEERING NEWS.

The Semi-Annual Convention of the National Association of Water Works Contractors was held at Saratoga August 26 and 27. A number of new members were elected, and the following papers presented;

The Building of Earth and Stone Reservoirs; Cast Iron Pipe; Pipe Laying; Gates and Hydrants; Pumping Machinery; Stand Pipe Construction, and a novel and interesting paper upon special castings, all which were referred to a revision committee.

There was a very enjoyable excursion to Mt. McGregor, the place of Gen. Grant's last days on earth, and drives and other attractions of Saratoga were enjoyed to the full.

Although this Association was started only last January, it already numbers nearly a hundred members; its aim as its constitution specifies, is to induce a greater harmony of feeling between Water Works Engineers, Contractors and their patrons and the recognition by all, that each has rights which the others are bound to respect, to create a standard of better and more thorough work, to eliminate those differences of opinion the existence of which all deprecate, and to establish a universal standard of construction by which all work will be judged.

MR. JOHN W. CLOUD, Engineer of Tests on the Pennsylvania R. R. has been appointed Mechanical Engineer, in place of the late Mr. J. B. Collin. The office of engineer of tests is now merged in that of mechanical engineer, who has charge also of the department of physical tests.

Canals in Russia.

A new canal, improving the water communication between the Caspian, and the Baltic, was opened by the Minister of Ways of Communication, Gen. Possiet, recently. The canal, which has cost £300,000 to construct, joins the rivers Wyhegra and Kovja, and forms a fresh link in the chain of waterways known as the Maryinsky system, connecting the Neva with the Volga. Its length is 22 versts, or 15 miles, width 70 feet, and depth 7 feet. Some of the cuttings through which it runs had to be excavated to the depth of 30 feet. Most of the work has been done by hand, upward of 20,000 laborers having been employed in the undertaking, together with three dredging machines, nine stationary engines, and two locomotives.

Upward of 270,000 Russian cubic fathoms of earth had been removed in making the canal, and two sluices constructed. Compared with the rest of the vast canal system between the Neva and the Volga, the new link was neither an extensive nor a formidable undertaking, but it has relieved the pressure of traffic on the other canals, and shortened the distance from Rybinsk to St. Petersburg. It is noteworthy, says *Engineering*, that in spite of the development of the Russian railway system the traffic on the canals shows no sign of diminution, a phenomenon quite the reverse of what has occurred in England. This is to be explained, perhaps, by the fact that distances are greater in Russia, while the canals are more like rivers than the narrow waterways common to England.

Barges on Russian rivers and canals range in length from 100 feet to 300 feet. The cargoes a large proportion of them carry, consequently, are as large as many an ocean cargo; and instead of being mere lighters, carrying only portions of cargoes, they are to all intents and purposes the counterparts of ocean-going ships. Thanks to the wide reaching ramifications of the river Volga, the largest in Europe, barges of 500 or 1,000 tons can start in the spring with the floods from some tiny stream in the Ural Mountains, and arrive in the autumn on the River Neva. On the other hand, it is possible for English steamers to make their way from the Neva through the canal system to the Volga, and thence descend to the Caspian Sea. The Neva-Volga canal system thus possesses an importance which no English canal could claim, although we think that water carriage in this country deserves to be rescued from its present neglected and decaying condition, into which it has lapsed through the instrumentality of ambitious and over-grasping railways.

THE MANCHESTER CANAL.—It is credibly reported that the Manchester Ship Canal scheme is to undergo resurrection shortly; the Manchester people are not to sit down quietly under the miscarriage of their favorite project. The situation has been reconsidered, and fresh alliances have been formed which promise a great increase of strength. Foreign capitalists are coming in, and the scheme, we are told, will reappear in a form which will preclude the idea of failure.—*Financial News*, London.

AN ARTESIAN WELL ON A TEAR.—A somewhat interesting story comes from Belleplaine, Ia., concerning the doings of an artesian well. It is said that when a 2 inch hole had been bored 180 feet deep the water burst forth with uncontrollable fury, rapidly enlarged the opening and defied all attempts to throttle it. At last accounts the city authorities were begging engineers from Chicago to come and choke it off, as it was flooding the town.

THE Smith, Beggs & Ranken Machine Company, St. Louis, Mo., have made a large recent shipment of pumping machinery to the Peacock Mine, in New Mexico.

THE Western Iron Boat Building Company, Carondolet, Mo., will build the five large 72-inch boilers required in connection with the new pumping engine at the water works. They have also taken several orders for repairs for Government boats.

BOILER SETTING.—Sealed proposals will be received at the office of the Board of Education, Brooklyn, until Tuesday, September 7, 1885, at 4 o'clock P. M., for furnishing and setting a boiler, building a chimney and for furnishing an engine and exhaust fan; also, for furnishing pin radiators for Branch School No. 25, Walworth street. Plans and Specifications can be seen at the office of the Chief Engineer, Red Hook Lane.

WILMINGTON, DEL.—The following is the amount of water pumped during August: City mill, Worthington pump, No. 1, pumped into Cool Spring reservoir 141,281,210 gallons, and the water power pump 26,668,230 gallons, a total of 167,949,440 gallons, or a daily average of 5,417,723 gallons. The Knowles pump at Cool Spring station pumped to Rodney street reservoir 23,641,968 gallons and Worthington pump, No. 2, 1,656,093 gallons, a total of 25,278,061 gallons, or a daily average of 816,066 gallons.

THE new tube works being erected at Youngstown, Ohio, by Matheson & Co., of Middletown, Pa., will be put in operation in about six weeks. Over 100 men are engaged in completing the plant. The works will be able to turn out wrought-iron pipe and tubes as large as 5 feet in diameter, whereas at present the largest wrought-iron pipe made is 16 inches in diameter. The product of the entire works will be 300 tons daily.

"J. D. MCINTYRE, Chief Engineer of the Sun River canal, Mont., says "that the water is now running through the Teton canal for a distance of eleven miles. The big lake reservoir will be eleven miles square and have an average depth of about 25 feet. It is calculated that it will irrigate 160 sections of land and also be one of the finest sheets of water in the territory. The great flume east of Prieste's butte will be a mile in length and cost between $16,000 and $20,000.

RECESSION OF NIAGARA FALLS.—At the recent meeting of the American Association for the Advancement of Science much interest was manifested in a paper of Professor R. S. Woodward, of Washington, on "the Rate of Recession of Niagara Falls." The Professor has lately madea survey of the falls and deduced figures there from which he explained at length. He said that the area of the rock worn away at the Horseshoe Falls between the years 1842 and 1875 was 18,500 square feet, equal to .425 acre; between 1875 and 1886, 60,000 square feet, or 1.37 acres. The main length of the contour of the falls is 2,300 feet. The time required to recede one mile, if the rate is 2. 42 feet per year, is 2,200 years. The minimum values for the yearly rate of recession, that is, the average rate along the whole contour, are: From 1842 to 1875, 2.44 feet; from 1842 to 1886, 2,38 feet.

LAKE CURRENTS.— Engineers in the employ of the Chicago Water Commission have devised an elaborate scheme of floats by which to ascertain the direction of the currents in Lake Michigan, from which the city water is drawn. The water about the pumping station far out in the lake is at present insufferably foul, and endeavors will be made to draw a supply from a locality where the city refuse does not make its way.

IRRIGATION IN CALIFORNIA.—State Engineer Hall of California, has issued a second memorandum on the irrigation question, in which he vigorously defends himself from the charge made by the San Francisco *Chronicle* that his plan for an irrigation system would encourage water monopoly. The engineer, by reference to published reports from his office, replies to the charge that he has not given publicity to similar information as appears in engineering reports in the colony of Victoria, on irrigation. He proves that the like information relating to California was much fuller than in the Victorian reprints, and cover in elaborate detail all the research thus far had concerning the flow of rivers, and the water supply of California. These denials and defenses Mr. Hall supplements by a chapter on the Australian system, prefacing it by saying that he has reported against general State construction, ownership and management of works, and in favor of State ownership, control and regulation of streams and waters; that he has never advocated prior appropriation as a permanent water-right system for the State, but has criticized it as a crude custom which would have at least to be hedged around with safeguards in the final laws. But he says he has spoken of the necessity for encouraging individual enterprise in irrigation, and of allowing wide latitude in favor of irrigation organization, and the necessity for forming districts where circumstances admit.

AN ENGINEER'S ALLEGED MISTAKE.—The engineer of Rapid City, D. T. in surveying for the water-works, located the reservoir several feet above the foundation head of the water supply, and now the water will not run into the tank, and, therefore, the city's $50,000 water system is of no use.—*Exchange Paper.*

SUPERINTENDENT L. J. WAGNER, of the Rome, Ga., water-works, has just finished laying the 8-inch water main on the bottom of the Oostanaula river, to connect the Bridge street main with the new DeSoto system of mains.

NEWARK.—The work of constructing the new extra High Service System for the supply of water to the upper portion of the city is completed, and water has been let into the mains. This system is designed to supply all the city west of Bergen street and south of Central avenue, and to relieve the old High Service System.

PRESSURE AND SPEED REGULATOR.—The Mason Regulator Co. of Boston have recently applied several of their speed and pressure regulators for the Blake and Knowles pump companies, on the Milford and Hyde Park, Mass. water works pump and other plants. The Pond Engineering Co. of St. Louis have taken the agency of the Mason goods for that city.

HERKIMER, N. Y.—The water works question was submitted to the vote of the taxable inhabitants of the corporation Tuesday, August 31. The voting was for and against water works. If the former proposition receives a majority of the votes, a subsequent election will be held to determine whether the village shall construct the works or a franchise be granted to outside parties. The vote was 131 to 102 in favor of water works.

SCHENECTADY.—The common council authorized the issue of 27 Schenectady city 3 per cent. bonds of $1,000 each, for sewer and water works improvements. The aldermen authorized the expenditure of $875 for procuring a map of the city.

THE National Iron and Brass Works, Dubuque, Iowa, have been awarded the contract for furnishing the pumps, etc., for the water works at Independence, Iowa. They will furnish two compound condensing duplex pumps, with a capacity of 1,000,000 gallons per day each. They are also shipping pumps to Knoxville Tenn., and recently received an order for a number of their bell-ringers from the Canadian Locomotive Works, at Kingston, Canada.

KIRKWOOD, Mo.—It is proposed to introduce a water supply from the Meramec river. Bids have already been received to do the work, from several companies, but the probabilities are that the Holly system will be adopted, and it is with a view to more accurate bidding that the plans and specifications are now being prepared. At present the idea is to utilize the flow of the Meramec for power, and in order to accomplish that a dam will be built across the stream. J. G. Cairns, architect, is preparing the plans.

NEWS OF THE WEEK.

CONTRACTING.

Brick Sewers.—The Town of Lake View, Ill., will let about four miles of main brick sewers on the 1st of October; the estimate cost is 108,000; this system will drain Ravenswood and Gross Park. J. W. Alvord is the Engineer.

Bids on East Orange Sewerage.—Opened August 27, 1886, B. T. Coyle, of Washington, D. E., lowest bidder on each and all sections, awarded contract at $135,257.58 for furnishing and laying all sewers, manholes, flush-tanks, ect. Extras at prices prescribed by Engineer. Work to be begun September 6.

Water Works.—Moffett, Hodgkins & Clarke, of Watertown, N. Y., have a contract to build water works for Rochester, Minn. The company has until July next to complete the works, which will be on the stand pipe and reservoir system. Robert E. Williams, C. E. of Jackson, Mich., made the plans and estimates, which were accepted by the city.

The Clayton Air Compressor Works of Brooklyn, N. Y., have just shipped to Sydney, Australia, a Duplex Air Compressor, having two 12-inch steam cylinders; two 8-inch air or gas cylinders and a stock of 26-inch. This compressor is fitted with all the latest Clayton improvements, which were the means of bringing the order to Brooklyn. It is designed to compress hydron-carbon gas to 300 pounds.

Storage Reservoir.—Sealed proposals for the construction of a storage reservoir on the line of the Annapolis Water Company's Works near Annapolis, Md., will be received at the office of W. H. Gorman, President, Nos. 23 and 25 German street, (Room 9), Baltimore, until 12 o'clock noon Monday, September 6, 1886, at which time the proposals will be opened by the Board of Directors, in presence of such bidders as please to attend.

Lighthouse—The contracts for material to be used on the Roanoke river (N. C.) lighthouse have been awarded. The bidders were Wm. D. Gill, Thos. Matthews & Son, H. A. Ramsay & Son, and Hirshberg, Hollander & Co., of Baltimore, and Louis H. Hoagland, of Portsmouth, Va. Wm. D. Gill was awarded the contract to furnish the lumber at $1,040; H. A. Ramsay & Son the iron work at $379.95, and Hoagland the oak and pine piles at $15 and $4 each, respectively. No contract was closed with Hirshberg, Hollander & Co. to furnish paint, glass, etc., at their bid of $151.80 on account of the small amount involved.

Bids.—Some time ago bids were opened by the supervising architect for sheet copper to be furnished certain public buildings. A remarkable similarity was observed in the bids. Some ten copper manufacturers bid $1.60 per sheet. The awards were held up until the matter could be investigated. The Baltimore Copper Rolling Company will have the furnishing of copper to be used on the buildings at Lynchburg, Va., and Erie, Pa., and C. G. Hussey & Co. are awarded the contract for copper required for the building at Council Bluffs, Iowa.

Buildings.

Sealed Proposals will be received until 2 P. M. on the 16 day of September, 1886, for furnishing and delivering at the Post Office and Courthouse Building, Baltimore, Md., all the sheet copper and slate required for roof.

City Hall.—The plans of E. E. Myers & Son, architects of Detroit, for the new city hall at Richmond, Va., have been adopted. The building will be of the Norman-Gothic style of architecture, having a front of 184 feet by 135 feet in depth, four stories in height and surmounted by a tower 198 feet high. It will be built of Richmond granite; rock-face work with finely cut granite trimmings cost $375,000.

Sealed Proposals will be received until 2 P. M. on the 20th day of October, 1886, for furnishing and putting in place all the iron furring, lathing and plastering required for the post office, etc., building at Baltimore, Md., in accordance with plans and specification, copies of which and any additional information may be had on application at the office of the Superintendent after September 15, 1885. M. E. Bell, Supervising Architect.

Building in Brooklyn,—The total of new buildings for which permits have been granted during the past eight months is 2,567 valued at $12,887,639 against 2,680 new buildings valued, at $13,945,730 for the same period last year, a loss of 113 in buildings and $1,058,091 in cost from the figures of 1885. The indications now are that the issue of permits for this year will very nearly reach the totals of last year, as there is a very decided activity being shown by builders, and September and October may be expected to exhibit large gains.

Fog Signal Buildings.—Sealed separate proposals will be received at room 142 Post Office building, Aug. 25, until 12 o'clock noon, on Friday, 10th day of Sep., 1886, for furnishing all materials and erecting complete two brick fog-signals buildings, one at Cape Ann light station, Thatcher's Island, Mass., and the other at Petit Manan light station, Me. Drawings may be seen and full specifications and information will be furnished on application to this office, or at No. 12 Central wharf, Portland, Me. W. S. Stanton, Major of Engineers, U. S. A. Engineer first and second lighthouse districts.

Railroads, Bridges and Canals.

Bridge.—A $3,000 bridge across Goose creek at Cochran's Ford, Loudoun, Va., will soon be constructed.

New Road.—The Gladwin (Mich.) *Record* says the surveyors are already running the line for the construction of the road to connect Gladwin with Bay City.

Harbors.—At a special meeting of the Quebec Harbor commissioners it was decided to adopt the new scheme submitted by the engineers for completing the works. The principal feature is a line of wall along-side the railway track on St. Andrew's street, with a special entrance for schooners by means of a lock. The Council of the Board of Trade will consider the scheme.

New Road.—A company has been formed at Henderson, Ky., to construct a road from Madisonville to Clayville in Webster Co. The road will be extended to the Ohio. Capital $50,000.

Car Building. - A Pennsylvania railroad official says the company was never more troubled than now to furnish cars to take care of its traffic. He added: "We are building at this time two cars every hour of the twenty-four, and expect to continue so to do until New Years." In other words, they were constructing 6,000 cars as rapidly as possible.

Washington Aqueduct Tunnel.—The engineer board of officers who recently made a survey of the great aqueduct tunnel north of the city, recommend a brick lining, and that the space between the wall and the brick be filled with dry rubble and cement.

Bridge Burned.—The Fort Leavenworth iron bridge over the Missouri river was burned on Wednesday night. The floor and a half mile of trestles were destroyed. It is the only means of the C. R. I. & P. R. R. to reach that city.

Charleston, Cincinnati & Chicago.—It is stated that arrangements will soon be made for putting the Massachusetts and Southern Construction Company at work in South Carolina, and this latter is now forming contracts for the sections in York county.

Tunnel for Streets.—The New Jersey Legislature has passed an ordinance providing that when streets have been improved to within 100 feet of a navigable waterway or basin, the city board having control of the streets may construct a tunnel and approaches to connect the streets on either side of the waterway.

Montreal Harbor.—Seven powerful steam dredges, two stone lifters and 200 men are employed in deepening the channel of the St. Lawrence river, under the direction of the Montreal Harbor Commissioners, to secure a uniform depth of 27½ feet, or 2 feet in addition to the results of former working. So effective are the dredges that very little blasting is done.

Lancaster, Pa. Prices.—The following bids for grading Fremont street were opened on the 26 ult.:

Francis Aucamp: Earth, 18 cents; rock, 40 cents.

Thomas C. Wiley: Farth, 18 cents; soft rock, 50 cents; solid rock, 60 cents.

John W. Musser: Earth, 17¼ cents; rock, 60 cents.

Frank Hinden: Earth, 18 cents; rock, 40 cents.

The contract was not awarded.

Railroad Mileage in 1886.—The *Railway Age* published a statement this week showing that in the two months that have elapsed since July 1st the total mileage of railway construction in the United States was nearly double that of the previous six months, and that the number of lines on which track laying was in progress was increased to 163. During the whole of 1885 3,131 miles of railway were built. Already, in the first eight months of 1886, this had been exceeded by 344 miles.

New Road.—The Glen Falls *Times* announces that a new railroad scheme is on foot, backed by Mr. Hughes of Granville and New York capitalists, to run through the slate region in Washington county, making connections at Rutland, Vt., with the Delaware and Hudson canal company, Central Vermont and Benrington roads. At its southern terminus over the Greenwich and Johnsonvill road it would connect with the Troy and Boston and Boston, Hoosac Tunnel and Western railroad.

New Croton Aqueduct.—Mr. Lacombe has sent his opinion to the Aqueduct Commissioners concerning the refusal of the contractors to obey the clause of the contract providing for suitable light and ventilation. The Corporation Council says that when any contractor violates any of the conditions of the contract, the commissioners have power to order the contractor to stop work and to continue it themselves at the expense of the contractor.

Minneapolis, Sault Ste Marie, and Atlantic R. R. Work is progressing on this road, and it is stated that it will be completed to Rhinelander, 100 miles from its present terminus, by October 1, and that another year will see it built to a junction with the Canadian Pacific R. R. Mr P. I. Mitchell, one of the contractors, says the work is going on as rapidly as could be expected. The portion under construction now is forty-four miles in length and extends from Brockville to Westport, Ont. All the contractors concerned are rushing things through. On his own contract he has nearly 500 men at work, whose wages average $1.35 a day and he has nearly six miles of completed road for tracklaying, which he expects will begin in September. He experiences a dearth of stone-cutters and masons. He began work on the 19th of June, and considers he can show a pretty good record of things accomplished. The distance from St. Paul to Sault Ste. Marie along the route adopted is about 465 miles. Thence to Montreal the distance is some 625 miles. The Canadian Pacific R. R. Co's. line now extends to Algoma, within less than 100 miles of St. Mary's river. The company will build this link to make connection as soon as the "Soo" road reaches its objective point, and will unite with it in building the international railway bridge. There will then be a through railway line from St. Paul and Minneapolis to Montreal, a distance of about 1090 miles, scarcely more than that from Chicago to the seaboard. The Grand Trunk R. R. Co. has but a short line to build to connect with the new system, and by virtue of these and other lines there will be through connections with every port in New England. Over the new road the distance to Portland will be shortened 250 miles, to Boston 125, while that to New York will remain about the same as by the Chicago lines.

CONTRACTORS INTELLIGENCE.

Engineering and Building Materials.

WHOLESALE PRICES.

Chicago, August 31, 1886.

IRON.

Quotations given by Carnegie & Co.

STRUCTURAL IRON.			
Angles	2.40	@	2.50
Steel, not in stock			
Tees			.2¼c.
Beams, channels, American			.3¼c.
Tank plates			2.40
Shell plates	3.00	@	.3¼c.
Steel plates, Tank			.3c.
WROUGHT-IRON PIPE.			
Butt welded, black.....Discount			.42½
" " galvanized... "			.32½
Lap " black... "			.55½
" " galvanized... "			.37½
Quotation by National Tube Co.			
Boiler Tubes			.50
RAILS.			
Steel	$37.00	@	$38.00
Old Rails—Iron	21.00	@	22.00
" —Steel	20.00	@	21.00
R. R. spikes			2.40
R. R. spice-plates	1.90	@	2.00
R. R. track bolts, square nuts			.3c.
Barb wire fencing, galvanized			.4c.
" " painted			.3¼
CORRUGATED IRON-SHEET.			
Wire gauge.....16 to 20	22	24	26
Black, per lb	3½	3⅞	3½ 3⅞
Galvanized per lb	8¾	9¼	9¼
Nos. 28			6.00 4
NAILS.			
Iron, per keg	2.10		
Steel, " "	2.20	@	2.25

METALS.

COPPER.			
Lake Superior			10.25
LEAD.			
Com. Domestic	4.75	@	4.80
Lead Pipe	.06¼	@	.06¾
Tin-Lined Lead Pipe	.15		
Sheet Lead	.07¼		
ZINC.			
Sheet	5.65		

BRICK.

Common.....per M	7.00	@	7.50
PRESSED.			
Chicago, Anderson	18.00	@	27.00
Indiana	16.00	@	22.00
Perth Amboy, Buff			50.00
" Mottled			50.00
Tiffany	22.00	@	30.00
St. Louis			27.00
Trenton	40.00		
Quotation by Lockwood & Kempest.			
Philadelphia			45.00
Baltimore			55.00
Milwaukee			25.00
Zanesville			30.00
" Enamelled			30.00
Toledo Red, common			12.00
" " stock			17.00
Fire Brick	25.00	@	30.00

LIME, ETC.

	Per Cask.		
Chicago Lime	.65	@	.75
Wisconsin "	.90	@	1.00
Hair—cattle, per bu	.20	@	.25
" —goat, " "			.40
Sand, Lake shore, per yd	1.00	@	1.25
Plaster of Paris	2.00	@	2.50

CEMENT.

Portland	3.25	@	3.50
Milwaukee, Utica, Louisville, Akron	1.00	@	1.25
Keene's Coarse	7.50	@	9.00
" Fine	11.00	@	12.00

STONE.

	Per cubic foot.		
LIMESTONE, Promiscuous blocks, f. o. b. cars; Chicago.			
Blue Bedford			.65
Buff			.55
Joliet	.35	@	.50
Lemont	.40	@	.50
FOUNDATION.			
Dimension, on dock	.16	@	.20
Rubble, per cord	.20	@	.25
Sidewalks, laid, 8" to 12" / 6" to 8" / sq. ft	.65	@	.75
Planed	.40	@	1.00
SANDSTONE, Promiscuous blocks.			
Amherst	.60	@	.75
Berea	.55	@	.65
Philadelphia brown stone			1.50
Connecticut "			1.50
Carbondale			1.10
Malone Blue Euclid	.55	@	.65
New York Bluestone	.35	@	1.40

MARBLE.

Cherokee Creole			1.70
Ettonah			2.20
Rutland	3.00	@	9.00
Concord			5.25
Sutherland Falls	2.50	@	5.50
St. Lawrence			5.00
East Dorset Italian	2.50	@	4.50
Mountain Park	2.25	@	6.00
Georgia			1.50
Vermont			3.00
Tennessee, Red	7.00	@	9.00
" Knoxville	2.50	@	5.00
Italian, Veined			4.90

Quotations given by Georgia Marble Co.

SLATE.

Green Roofing, per square			5.20
Purple " " "			6.00
Red " " "			12.50
Black Lehigh " "	5.25	@	5.50
" Chapman's " "	7.30	@	8.00
" Bangor " "	5.50	@	5.80

LUMBER, Car Lots.

			Per M.
THICK CLEARS AND SELECTS.			
Mixed Lengths, Dry.....Rough	20.00	@	47.00
ONE INCH FINISHING.			
Mixed Lengths, Dry.....Rough	24.00	@	47.00
12-INCH STOCK BOARDS.			
D to A	23.00	@	42.00
Common Stock Boards	11.50	@	16.00
Box BOARDS, D to A	22.00	@	24.00
FLOORING STRIPS, ROUGH, 6-INCH.			
1st and 2nd clear			39.00
A Siding Str ps			30.00
C and A Flooring "	22.00	@	30.00
FLOORING DRESSED AND MATCHED.			
D to A, 6-inch	17.00	@	34.00
No. 1 Fencing	13.00	@	15.00
Norway, clear, C to A	17.00	@	22.00
8 and 10-inch No. 1 Boards, D and M	14.50	@	15.00
C to A Partition D and M, 2 sides, 4 beads	27.00	@	30.50
Beaded C and King, Tied	14.50	@	32.00
Common and Cull, Boards, Dry	11.00	@	13.00
Common and Cull, Fencing	11.50	@	13.50
BATTENS.			
O. Gt. or Beveled per 100 lin. ft	.50	@	.70
TIMBER, JOISTS AND SCANTLING.			
All 2x4, 12 to 24 ft	$12.00	@	$13.50
" 2x6, "	12.00	@	16.00
" 2x8, "	12.00	@	14.50
" 2x10, "	12.00	@	16.00
" 2x12, "	12.00	@	17.00
4x4 to 8x8 "	12.00	@	15.00
2 inch cull, plank, prom" width			9.00
2x4 " " 1½, 14 and 16 ft			10.00
BOARDS, ordinary dimensions.			
Pine, 1st quality clear	$46.00	@	$48.00
" 2nd " "	44.00	@	47.00
" 3rd " "	42.00	@	44.00
Common			13.00
SIDING.			
Pine	10.00	@	21.00
FRAMING TIMBER, Pine	12.00	@	17.00
Laths "			1.75
Shingles " sawed	2.10	@	2.40
" cedar	2.00	@	2.20
Pickets, pine	9 00	@	19.00
Posts, cedar	9.00	@	21.00
Pine, yellow southern	28.00	@	35.00
PINE, YELLOW GEORGIA,			
1st and 2nd clear, 4 inch flooring			35 00
" " " 6-inch "			35.00
Boards	33.00	@	35.00

HARDWOODS.

Ash, 1st and 2nd, 1 inch	23.00	@	25.00
Maple, " " " "	20.00	@	21.00
Walnut " " " "	100.00	@	175.00
Oak White, 1st and 2nd, 1 inch	16.00	@	38.00
" Red " " " "	23.00	@	24.00
Cherry " " " "	65.00	@	85.00
Beech, Red " " " "	25.00	@	30.00
Whitewood " " " "	24.00	@	28 00
Birch, Red, 1st and 2nd, 1 inch	23.00	@	25.00
Butternut " " " "	30.00	@	40.00
Sycamore " " " "	22.00	@	25.00
Gum " " " "	20.00	@	23.00
Basswood " " " "			40.00
Hickory " " " "	26.00	@	30.00
Elm " " " "	14.00	@	16.00
Chestnut " " " "	32.00	@	37.00
Rosewood, per lb	8c.	@	15c.
Mahogany, Mexican, per lb	.15c.	@	.20c.
" St. Domingo, per lb	.20c.	@	.25c.
" Cuba, per lb	.12c.	@	.20c.
California Redwood Lumber	42 50	@	44.50
" Shingles	4.60	@	4.90
" Pine	65.00	@	75.00
Mexican Spanish Cedar	150.00	@	300.00
Georgia Cypress Lumber, 1st and 2nd clear	35.00	@	40.00
Georgia Cypress Shingles	3.75	@	4.25
CALIFORNIA OAK.			
Plank	23.00	@	25.00
Timber	24.00	@	30.00

PAINTS.

	Dry.		In Oil.
Lead, White (American) Dry	7		7½
Zinc "	8, 10, 10	@	12
Red Venetian	2.6		12
Vermillion		2 @	75
India Red		15 @	20
Yellow Ochre		6 @	10
" Chrome	12 @ 20	12 @	20
Green "	12 @ 15	10 @	16
Black, Lamp	8 @ 25	10 @	15
Putty.....Bulk		.2 Bladders	.3
Blue, Ultramarine	.16		.35
Whiting, dry	.1		
Litharge—American	.7		
Sienna, burnt	.9		.16
Umber, burnt	.7		.16
Oil, Linseed (raw) per gal	.44		
" (boiled) "	.47		
Turpentine "	.36		
Varnish, coach	1.25	@	2.00
" shellac	3.25	@	4.00

ASPHALT.

BARBER ASPHALT.			
Pavements Laid:			
Without foundation, per sq. yd			2.60
With " " "			3.00
Asphalt Blocks:			
Macadam foundation, per sq. yd	2.81	@	2.97
Without macadam foundation, per sq yd			2.75

Contractors Intelligence,

Reported by T. H. Boorman.

Engineering and Building Materials.

WHOLESALE PRICES.

New York, September 2, 1886.

IRON.

STRUCTURAL IRON.		
Angles	1.95c	@ 2.10c
" steel	2.35	@ 2.45
Tees	2.35	@ 2.45
Beams and channels, American	3.0	@
Tank plates	2.10	@ 2.20
Shell plates	2.4	@ 2.5
Steel plates, Tank	2.70	@ 2.75
WROUGHT-IRON PIPE. PITTSBURG.		
Butt welded, black ... Discount		45
" " galvanized ... "		35
Lap welded, black ... "		60
" " galvanized ... "		42½
Boiler tubes ... "		52½
RAILS.		
Steel (large lots at mill)	$34.00	@ $34.50
Old rails	20.00	@ 20.50
Old rails, steel	22.00	@ 23.00
R R. spikes		2.40c
R R. splice-plates	1.80	@ 2.00
R R. track bolts, square nuts	3.00	
Barb-wire fencing, galvanized	4.00	@ 4.38
" " painted		4.00
Corrugated iron		
Nails		
Iron, per keg	2.10	
Steel do.	2.20	@ 2.25

METALS.

COPPER.		
Lake Superior	10.25	@ 10.38
Other Brands	9.8-25	@ 9.75
LEAD.		
Com. Domestic	4.75	
Lead Pipe	.06¼c.	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.07¼	
ZINC.		
Sheet	5.60	@ 5.85

BRICK.

Cargoes (afloat)		
Choice Brands	7.25	
Haverstraw ... per M.	6.25	@ 7.25
Fishkill	6.25	@ 6.50
Up-River	5.50	@ 6.25
Jerseys	5.50	@ 6.00
Long Island		
Pale	4.50	@ 4.75
FRONTS.		
Croton, red	11.00	@ 15.00
" dark	11.00	@ 15.00
" brown	10.00	@ 14.00
Philadelphia pressed	27.00	@ 28.00
Trenton "	25.00	@ 26.00
Baltimore "	37.00	@ 41.00
Buff "	33.00	@ 35.00
Enameled English	85.00	@ 130.00
" American	80.00	@ 120.00
Fire brick	25.00	@ 55.00
" American, No. 1	30.00	@ 35.00
" " No. 2	25.00	@ 30.00

ASPHALT.

ROCK.		
French	$20.00	@ 25.00
German	15.00	@ 20.00
According to quantity or brand, and whether taken from vessel or store.		
PAVEMENT.		
Barber's Asphalt	$2.50	@ $3.00

LIME.

Rocklock Cement Co.'s Ground	.80
Rockland, common per bbl	1.00
" finishing	1.20
State, common	.85
" finishing	1.05
Kingston, ground	.90
Add 25c. to above figures for yard rates.	

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.95	@ 1.00
" " No. 2 "	0.75	@ 0.85
" " light drab "	0.80	@ 0.95
Berlin " in rough "	0.75	@ 1.00
Berea " " "		
Brown stone, Portland, Ct. "	1.00	@ 1.35
" Belleville, N. J. "	0.75	@ 1.35
Granite, rough	0.45	@ 1.25
Common building stone per load	2.00	@ 3.00
Base stone, from 2¾ to 6 ft. lengths, per lin. ft.	0.40	@ 3.00
Concrete and macadam stone, Tomkins Cove, per cub. yd		$1.65

SLATE.

Purple roofing per square	6.00	@ 7.00
Green "	6.00	@ 7.00
Red "	15.00	
Black Penna. (at New York) "	4.50	@ 5.00

LUMBER.

Prices for yard delivery in New York.

PINE, Common box per M.	18.00	@ 20.00
" Choice "	65.00	@ 70.00
Tally plank, 1¼ in. 10 in. dres'd, each.	.44	@ .50
Tally boards, dressed com. "	.28	@ .30
SPRUCE, Boards dressed "	.25	@ .28
Plank, 1¼ in "	.38	@ .39
" 2 in. "	.38	@ .40
" 2 in. dressed "	.43	@ .45
Timber per M.	13.00	@ 18.00
HEMLOCK, Boards each.	.16	@ .20
Joist, 2¾ × 4 to 4 × 6 in	.16	@ .44
OAK per M.	55.00	@ 65.00
CYPRESS 1, 1¼, 2 and 2¼ in "	35.00	@ 40.00
YELLOW PINE, Girders "	25.00	@ 30.00
Dressed flooring "	28.00	@ 35.00
SHINGLES, Extra shaved pine, 16in. "		
" sawed 18 in. "	5.75	@ 6.00
LATH, Cargo rate "	2.00	@ 2.10

PAINT.

Lead, white, American dry per lb	.04¾	@ .06½
" " " in oil pure "	.07	@ .07½
" English, B. B. in oil	.08½	@ .09¾
" Red, American	.06½	@ .07
Litharge "	05½	@ .06
Venetian red, American "	.01	@ .01¾
Indian red "	.08	@ .10
Vermillion, American lead "	.10½	@ .11½
Paris green "	.15	@ .18
Umber, Amer. raw and powdered per lb.	.01¼	@ .01¾
Drop black, Amer.	.07	@ .13
" " Eng.	.11	@ .13
Chrome green	.19	@ .25
Oxide zinc, American	.03½	@ .03¾
" French	.05½	@ .07½

CEMENT.

The following price current is made up entirely from quotations furnished us directly by the firms dealing in each brand; the prices are understood to be Wholesale in New York, subject to such special rates as large quantities may warrant:

CALVIN TOMKINS:		
"Old Newark Co's." Cement		$1.10
BAETJER & MEYERSTEIN:		
Hanover Portland	$2.60	@ $2.65
BELLONI & Co.:		
Hemmoor "Crown" brand		2.50
JAMES BRAND:		
Burham	2.25	@ 2.50
Fewen	2.25	@ 2.50
BROOKS, SHOOBRIDGE & Co.	2.45	@ 2.60
HOWARD FLEMING:		
Gibbs' English Portland, 400 lbs.	2.50	@ 2.75
K. B. & S. "	2.25	@ 2.50
Stettiner, German	2.65	@ 2.85
Lagerdorfer, "	2.45	@ 2.75
Fieve, A 1, Belgian	2.35	@ 2.50
Roman	2.75	@ 3.00
Keene's Coarse	4.75	@ 5.50
" Fine	7.75	@ 8.50
" Superfine	8.50	@ 10.00
FISHER, ERSKINE W.:		
Stettin (German) Portland Cement	2.40	@ 2.75
GABRIEL & SCHALL:		
Vorwohler "Lion"	2.65	@ 3.10
HUDSON RIVER CEMENT Co. Rosendale		0
JOHNSON & WILSON:		
Saylor's American Portland	2.15	@ 2.45
LESLEY & TRINKLE, Philadelphia, Pa.:		
"Giant" Portland	2.20	@ 2.40
Improved "Union"	1.25	@ 1.50
Union	1.10	@ 1.20
MABCIAL & Co.:		
J. B. White & Bros. Coarse Keene's	4.25	@ 4.50
" Superfine	7.25	@ 7.50
" Portland	2.65	@ 3.00
NEW YORK CEMENT Co.:		
Rosendale		1.10
N. Y. & ROSENDALE CEMENT Co.:		
Rosendale, "Bridge" brand		1.10
SINCLAIR & BAUSON:		
Alsen's Portland Cement Works	2.35	@ 2.85
K. B. & S.	2.25	@ 2.50
STANDARD CEMENT Co		
E. THIELE:		
Dyckerhoff	2.90	@ 3.25
UNITED STATES CEMENT Co.:		
English Portland	2.25	@ 2.40
German "	2.00	@ 2.15
Standard	1.50	@ 1.65
Windsor and Improved Rosendale	1.00	@ 1.10
UNION AKRON CEMENT Co.:		
Akron "Star" brand.	1.00	@ 1.10

MARKET SUMMARY.

The brick market is buoyant, sales are readily made at quotations, consumption free and arrivals hardly up to the demand, prices are firm. Haverstraws sell at $6.50 @ 7.00 per M., with special makes as high as $7.25. Fishkill has been sold at $6.50, other up river brick at $5.50 @ $6.00, a noticeable feature in the market this season is the fact that Pale and Jerseys have maintained their prices and are in good demand. Pressed brick are meeting with a fair enquiry at recently quoted prices. The Lumber Market is steady, small-sized Spruce Randoms are selling at $13.00 to $14.00 per M., large widths, $15.00 to 16.00 per M., and heavy schedules on order at $18.00 per M. Yellow Pine is unchanged at last week's prices, special cargoes being quoted $19 50 to 21.00 per M., dry flooring boards, $21.00 to 22.00 per M. Lath does not drag on the Market and large cargoes have been sold at $2.00, and small cargoes, or broken lots, at $2.10 per M. for both St. John and Maine consignments. The Hardware Market does not yet show any marked activity, slight deviations from list prices are still made. Nails seem to be only moving for actual necessities, quotations remaining $2 10 @ 2.20 per keg, for 10d. to 60d. The Cement Market is still quoted slow on sales of Rosendale, but the demand for imported Portland continues and importers find little difficulty in placing known brands on or before arrival, at prices ranging from $2.15 to 2 35, ex-ship for 300 to 500 barrel orders. Lime is unchanged at $1.00 per barrel for common Rockland, $1.20 for finishing. Dealers are not overstocked and consignments are placed on arrival without difficulty. Plaster is in seasonable demand, a sale of Red Beach is reported this week for export at $1.20 per barrel ex store. No change in the price of Hair. Paints are in good demand, particularly colors for Mortar, with no change in card rates. Linseed Oil is not quite so firm, and sales of City have been made at 42 cents per gallon. Turpentine also has had a slight drop and is now quoted at 34½ cents per gallon. Pig tin has been quiet, not having received so much notice from speculators, and is quoted as last week at $22.10 for Straits. Tin plates have shown signs of weakened prices in sympathy with a break in foreign quotations, and the market is uncertain. Zinc is quoted at 5½ to 5¾ cents per pound by the cask.

BUILDING ITEMS.

Mr. G. Palmer Graves, No. 10 W. 23rd street, reports sketches on the boards for eight brick stone and terra-cotta residences which Dr. Reynolds proposes to erect on 94th street, near Eleventh avenue, at a cost of about $70,000, he has also designed a residence to be built at Flushing, L. I., for Mr. J. J. Staples, at a cost of $15,000, and alterations to be made at a cost of $6,000, to the residence of Mr. J. W. Copman, at Bay Ridge, L. I.

Mr. Augustus Hatfield is the architect for a ten-story, fire-proof apartment house to be erected by a Home Club Association organized by Mr. Chas. A. Garlach to be built on the north side of 27th street, 100 feet east of Sixth avenue, at a cost of about $460,000.

Messrs. D. & J. Jardine have prepared plans for Sunday-school rooms 40x45, to be added to the First Congregational Church at Stamford, Conn. Cost not yet estimated.

Mr. S. B. Reed, 245 Broadway, has prepared plans for a two-story brick and terra-cotta stable 25x85, to be built for Mr. James A. Bailey, on the north side of 150th street, between St. Nicholas and Tenth avenues, to cost about $12,000.

Mr. T. Englehardt, of 779 Broadway, Brooklyn, has drawn plans for the new Arion Hall, 60x80, to be built for the Brooklyn Arion Singing Society at Nos. 13 to 19 Wall street, that city, at a cost of $40 000.

Messrs. D. & J. Jardine have prepared plans for a two-story brick extension, 65x110, to be made to the premises of the New York Gas Engine and Power Co., on the northwest corner of Brook avenue and 131st street. Cost not yet estimated.

Mr. J. F. Burrows is preparing designs for Art Sale Rooms, 50x100 four stories high of buff brick and terra-cotta, to be built for Mr. Justin Cooke, on the north side of 125th street, east of Third avenue, at a cost of about $40 000.

Messrs. C. Abbot French & Co., 209 W. 57th street, report plans on the boards for a five-story and basement brick tenement house, 25x85, with factory adjoining, 33x95, also five-story and basement brick front, to be built on the north side of 36th street, 150 feet west of Eleventh avenue, for Mrs. F. Riegel, at a cost of $36,000.

The contract for building the new Depot for the 42nd street R. R. Co., has been awarded to Mr. W. C. Whyte, 15 Cortlandt street.

Mr. Frederick C. Withers, of the Bible House, has drawn plans for four buildings to be added to the Hudson River State Hospital, Poughkeepsie; estimates for their erection will be received up to September 11th.

Mr. John G. Prague, 47 Bible House, has drawn plans for five four-story and basement brick residences, 20x56 each, which he will have built on his own account, on the north side of 86th street, 110 feet west of Ninth avenue, at a cost of $110,000.

Messrs. Cleverdon & Putzel have drawn plans for four three-story and basement brown-stone dwellings, to be built for Mr. Stephen J. Wright, at a cost of about $50,000, on the north side of 130th street, 325 feet east of Eighth avenue.

Messrs. W. J. Merritt & Co., architects and builders, 152 W. 129th street, will erect, on the northeast corner of West End avenue and 75th street, ten four-story and basement brick residences at a cost of about $180,000.

Mr. John Sexton, 1,456 Broadway, has completed plans for four five-story brick tenements and stores to be built on the northeast corner of 81st street and First avenues, at a cost of about $65,000. Messrs. Van Dolsen & Arnott, builders.

In August plans for 323 new buildings, to cost $4,161,335, were submitted to Superintendent D'Oench.

Mr. George A. Freeman, Jr., informs us that the hotel and cottages for which he had reported plans on the boards are to be erected for a syndicate of capitalists at Southampton, L. I., at a cost of about $100,000.

Mr. John W. Decker will build fourteen three-story frame houses on the east side of Jackson avenue, 145 feet south of 165th street, at a cost of $38,000, and two on Forest avenue at a cost of $7,600.

Mr. John Sullivan will build six five-story flats with stores to cover the entire front, on the west side of Seventh avenue, from 123rd to 124th street, at a cost of $128,000.

Eight sets of plans and specifications for the proposed armories of the Eighth and Twenty-second Regiments having been received by the Armory Board they were sent for examination to a committee, composed of Gens. Newton and Fitzgerald and Col. Clark, who will meet and pass on them, with the aid of an expert builder, on Monday next, at 2 P. M., in the Tax Commissioners' office.

BROOKLYN.—The close of the month of August shows the following issue of permits for new buildings as compared with August, 1885:—

	Buildings.	Cost.
August, 1886	415	$1,953,575
August, 1885	376	1,745,420
Difference	39	$203,155

On Halsey street, east of Nostrand avenue, Messrs. H. B. Moore and William O. Thompson are about to build six brick private residences, 17.6x42, three-story and basement, with extension, 12x10, to cost $30,000.

On the north side of Putnam avenue, east of Sumner, Mr. A. Stewart Walsh is about to build five brown stone front private residences, 20x42, two and a half stories and basement, with extension 12x9, to cost $32,500.

On 27th street, east of Fourth avenue, Mrs. Matilda Goodwin is about to build five three story brick houses, 20x50, for three families each, to cost $20 000 altogether.

On President street, west of Eighth avenue, Mrs. Sarah H. Burckett is about to build two brick private residences, 30x52, and three stories, to cost $24,000.

At 149 Washington street, Mr. Morse Bartis is about to build a five-story brick, stone and terra-cotta house, 30x96, for eighteen families and two stores, to cost $25,000.

On Greene avenue, west of Nostrand, Mr. Alexander L. Baird is about to build five brown stone front private residences, 20x45, three stories and basement, with extension 11x12, at a cost of $20,000.

A permit has been granted to the St. Paul Parochial School to build a three-story brick school house, 87x108.6 feet on Warren street, near Clinton, at a cost of $38,000.